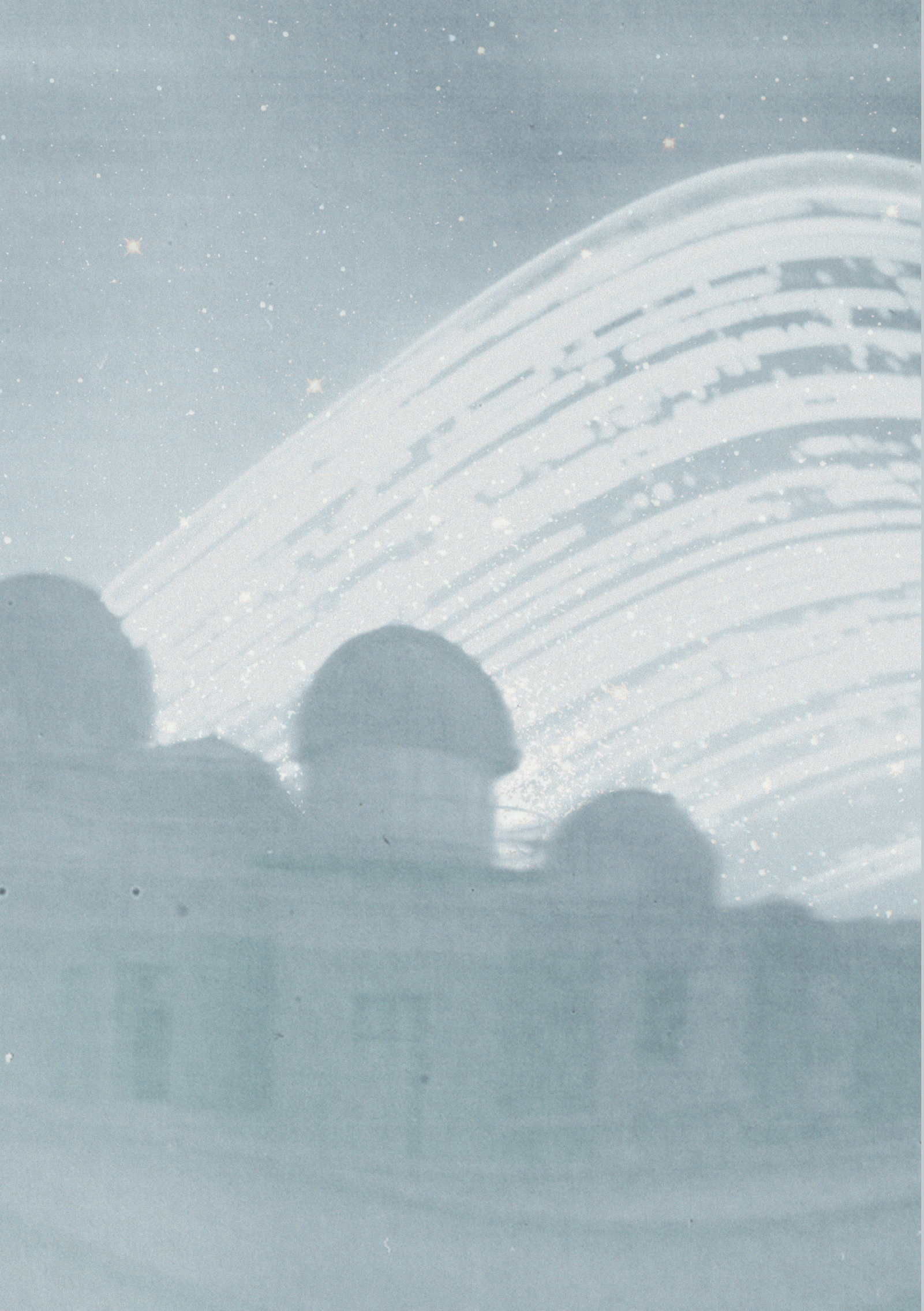
Annual Report

21

Research Institute Leiden Observatory

Onderzoeksinstituut Sterrewacht Leiden



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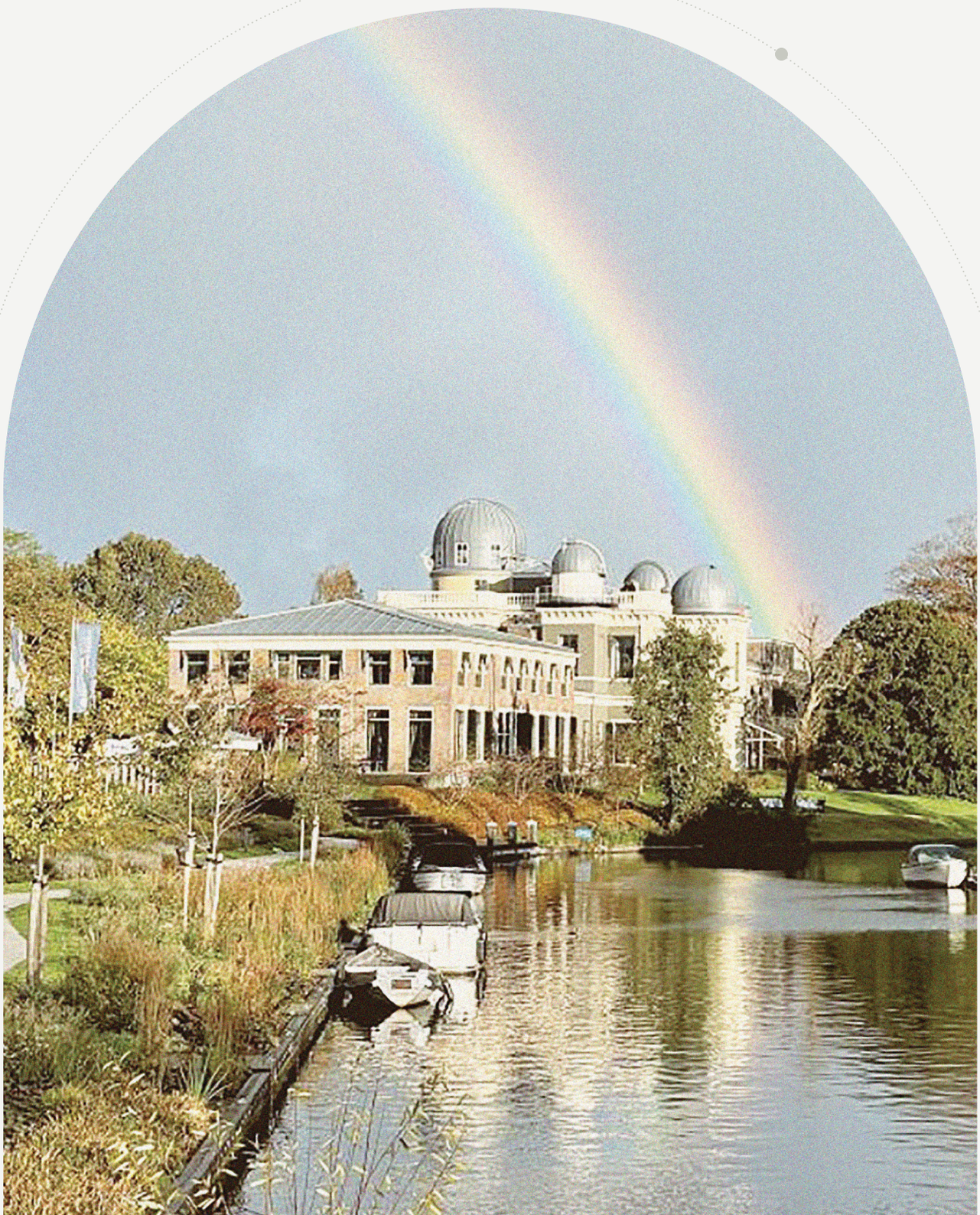
Foreword



Credit: Violette Impellizzeri

Dear Reader

Corona has continued to have a huge impact in 2021. During the first half of the year, many restrictions were in place and life only went back more or less to normal in June when, for example, restaurants could remain open until 10pm. Even though the number of infections again seriously rose during the summer and stayed at a very significant level during the rest of the year, the universities remained open with the general advice to work from home if possible. All of this had an enormous influence on life at the observatory. For our staff and teaching assistants, the biggest challenge was to continue to give the courses either completely remotely or in some kind of hybrid scheme with part of the students in a classroom and the rest in front of a screen at home. All of this was not easy, but it went remarkably well. Our Education Office also had an extremely busy time. With the governmental measures altering continuously - sometimes abruptly - there was a lot of work and improvisation involved in maintaining the education schedules, finding practical solutions for remote teaching, and helping students in these difficult times. Amazingly, it all worked out and a big compliment to all that ensured that our master and bachelor students could progress with their studies. A major issue was ensuring the well-being of all the Sterrewachters and our Social Support Committee developed many activities that really helped out. In addition, at the end of each Friday afternoon, the Observatory Seminar was a well-attended event that allowed us to exchange information on what was happening not only at the observatory but in our larger community as well. And the 15-minute science talk by one of us was a reminder of the breadth and quality of the science we are carrying out.

Despite the lockdowns, our research excelled. A few very nice highlights are discussed in this yearly report and the staggering number of 690 refereed publications is an all-time high. Despite the lockdowns, many new students, PhD students and postdocs started and 45 bachelor, 32 master and 18 PhD students were awarded their degrees. Congratulations to all of them! Also, three new staff members joined us: Mariska Kriek, Aline Vidotto and Nienke van der Marel –welcome! In this Annual Report they share their first impressions of life at the observatory and in the Netherlands. Additionally, and again despite the lockdowns, the beautiful SRON building was finished, and at the end of the summer the full move from Utrecht was completed. We are looking forward to actively strengthening our ties and enhancing our collaborations with SRON.

One of the things we are very proud of is the prizes that have been awarded to our Sterrewachters. Leiden Observatory PhD candidate Danna Qasim has won the IAU PhD Prize and the Outstanding Dissertation Award from the American Chemical Society. Joe Callingham was awarded the Louise Webster Prize from the Astronomical Society of Australia for outstanding post-doctoral research. Ewine van Dishoeck received the prestigious Jules Janssen Prize by the Société Astronomique de France for her “outstanding scientific work as well as for her contribution to public appreciation of astronomy”. And we can agree that it is very special that Pope Francis appointed Ewine to the Pontifical Academy of Sciences, an international academy of 80 leading scientists from around the world representing the full spectrum of sciences and the global scientific community. The academy’s mission is “to honour pure science wherever it may be found, ensure its freedom and encourage research for the progress of science”.

When two years ago I was given a third term as director of our beautiful institute I was honoured and felt privileged. I have really enjoyed and still am really enjoying my current role. However, I have never made it a secret that completing this third term was not my plan and that after 10 years of me being in this post, it would be a good time to move on, both for the institute and for me. And I can already say that I am very pleased with the new director that will likely start at the end of the summer of 2022. Hence, this is the last introduction that I will write for our yearly report. While this is not the place to start looking back in any detail, my overall feeling is that I am very happy that over all these years together we could continue to strengthen our position as one of the leading institutes for astronomical research, education and outreach. Thanks all for the advice, help, and collaborations.

Huub Röttgering

Director

Leiden Observatory

The mission of Leiden Observatory is to carry out world class astronomical research, provide an excellent education at the bachelors, masters, and PhD level, and inform the general public about the most exciting astronomical results and the beauty of the Universe. Our research is wide ranging, with a particular emphasis on observational and theoretical studies of galaxies and the structures in which they are embedded, on exoplanets, and on star and planet formation.

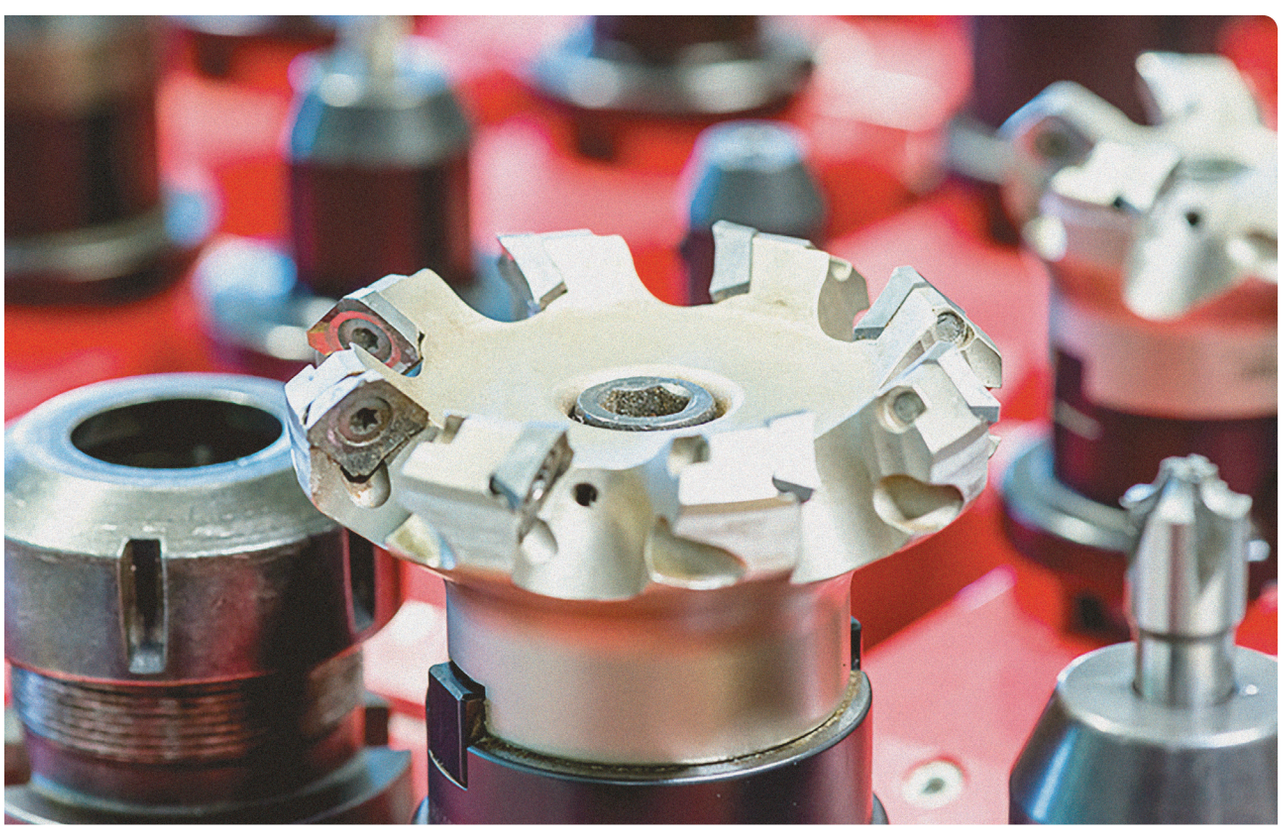
The Observatory and its people

Sterrewacht Leiden was founded by Leiden University in 1633 to house the quadrant of Snellius, making it the oldest operating university observatory in the world. While originally located at the main Faculty Building of the university, a purpose-built observatory was constructed in the university's botanical gardens in 1860. Since the mid-1970s the institute has been located within the campus of the Faculty of Science. A long list of eminent astronomers has populated the Sterrewacht, including Profs. Willem de Sitter, Ejnar Hertzsprung, Jan Oort, Adriaan Blaauw, and Henk van de Hulst. Currently, Leiden Observatory is proud to be one of the largest and top astronomical research institutes in Europe. It has about 29 full time scientific staff members, 55 postdoctoral researchers, 100 PhD students, 129 Masters students and 267 Bachelor students. Among its professors are three Dutch Spinoza Prize winners: van Dishoek, Franx and Tielens. Prof. Ewine van Dishoeck is the president of the International Astronomical Union (2018-2021).

Research and Technology

Scientific research at Leiden Observatory ranges from studying how the Earth and the Solar System have formed and how this compares to other planetary systems, to the origin and evolution of the Milky Way and the Universe as a whole. Observations play a central role in astronomical research, and the state of the art instrumentation is almost exclusively built and operated through international collaborations. Optical and infrared ground-based observations are mostly conducted with telescopes from the European Southern Observatory (ESO) in Northern Chile, and from the Isaac Newton Group (ING) on La Palma (Canary Islands, Spain). Flagship telescopes at other wavelength regimes are the Atacama Large mm/sub-mm Array (ALMA) in Chile and the international Low Frequency Array (LOFAR), which has its core in the north of the Netherlands. Other observations can only be conducted from space, meaning that Leiden astronomers also frequently use the NASA Hubble Space Telescope. A second pillar of astronomical research is theoretical and astrochemistry modelling. Large-scale numerical simulations and big data are key ingredients of astronomical research. Leiden Observatory hosts the Laboratory for Astrophysics, which carries out unique experiments to simulate inter- and circumstellar conditions in a controlled environment.

Leiden Observatory is also focused on driving the development of key technologies that will enable future astronomical discoveries. Close collaborations with Dutch partners are crucial, such as the NOVA optical group at ASTRON, TNO Space, the Netherlands Institute for Space Research (SRON), and Airbus (Leiden). Ultimately, most instruments are built in international consortia under the umbrella of ESO or the European Space Agency (ESA). In this way, Leiden astronomers play important roles in the development and operation of the ESA's GAIA and EUCLID missions. Leiden professor Bernhard Brandl is the NOVA principal investigator of METIS, one of the first light instruments of the future Extremely Large Telescope (ELT).



Bachelor and Master education

Leiden Observatory is part of the Faculty of Science and hosts both the Bachelor and Master studies in astronomy of Leiden University. By the end of the year, the three year Bachelor in Astronomy is followed by about 260 Bachelor students, and provides a broad basis in astronomy, with important components in physics, mathematics, and informatics. In the same period the two year Masters in Astronomy is followed by about 129 Masters students. Since it is fully taught in English it is also very popular among non-Dutch students. The master not only prepares students for a scientific path, but also launches careers in business or industry.

Public Engagement

An important task of Leiden Observatory is to engage the general public with the wonders of the universe, and share the scientific, technological, cultural and educational aspects of astronomy with society.

The institute operates a centre at the historic Observatory building in the centre of Leiden. In cooperation with the astronomy student club L.A.D. F. Kaiser the institute organises tours to get an inside look at one of the historic telescopes. Before Corona imposed restrictions on our social activities, about 150 tours per year were organised – a number we hope to return to in the not too distant future.

Calendar of Events 2021

JANUARY

FEBRUARY

MARCH

APRIL

MAY

JUNE

Opening second entrance to the Old Observatory premises by alderman Ashley North [02]

14th Nederlandse Sterrenkunde Olympiade at Leiden Observatory [09 – 11]

Livestream Leiden Observatory Solar Eclipse with more than 20.000 views [10]

Leiden/ESA Astrophysics Programme for Summer Students (LEAPS) [Jun. – Aug.]

Donggang Wang awarded Rubicon fellowship [21]

Largest European astronomy congress (EAS) for second time organised by Leiden Observatory [28 – Aug. 02]

Open Science Hub (coordinated by Leiden University, principal investigator Pedro Russo) receives 2021 Medal of Scientific Merit in Portugal [29]

JULY

Joe Callingham awarded the Louise Webster Prize from the Astronomical Society of Australia for outstanding post-doctoral research [13]

Online summer programme “Space in Your Living Room” by Leiden Observatory awarded price for the Most Innovative Event of the IAU [Jul. – Aug.]

AUGUST

Ewine van Dishoeck elected member of the Pontifical Academy of Sciences by Pope Francis [03]

SEPTEMBER

Observatory Beach BBQ [21]

Observatory Movie Evening (“Dune”) [29]

OCTOBER

Thomas Wijnen four weeks on “Mars Mission” in Negev desert, Israel [15 – 16]

Start of the Shared Sky exhibition at the Old Observatory [16]

A '10' for Leiden astronomy student Arend Moerman who simulated chaotic interactions of black holes [29]

NOVEMBER

PhD introductory Event in Noordwijk [03 – 05]

Marijn Franx, Joop Schaye, Rychard Bouwens and Tim de Zeeuw on the 2021 Highly Cited Researchers list of Clarivate Analytics [19]

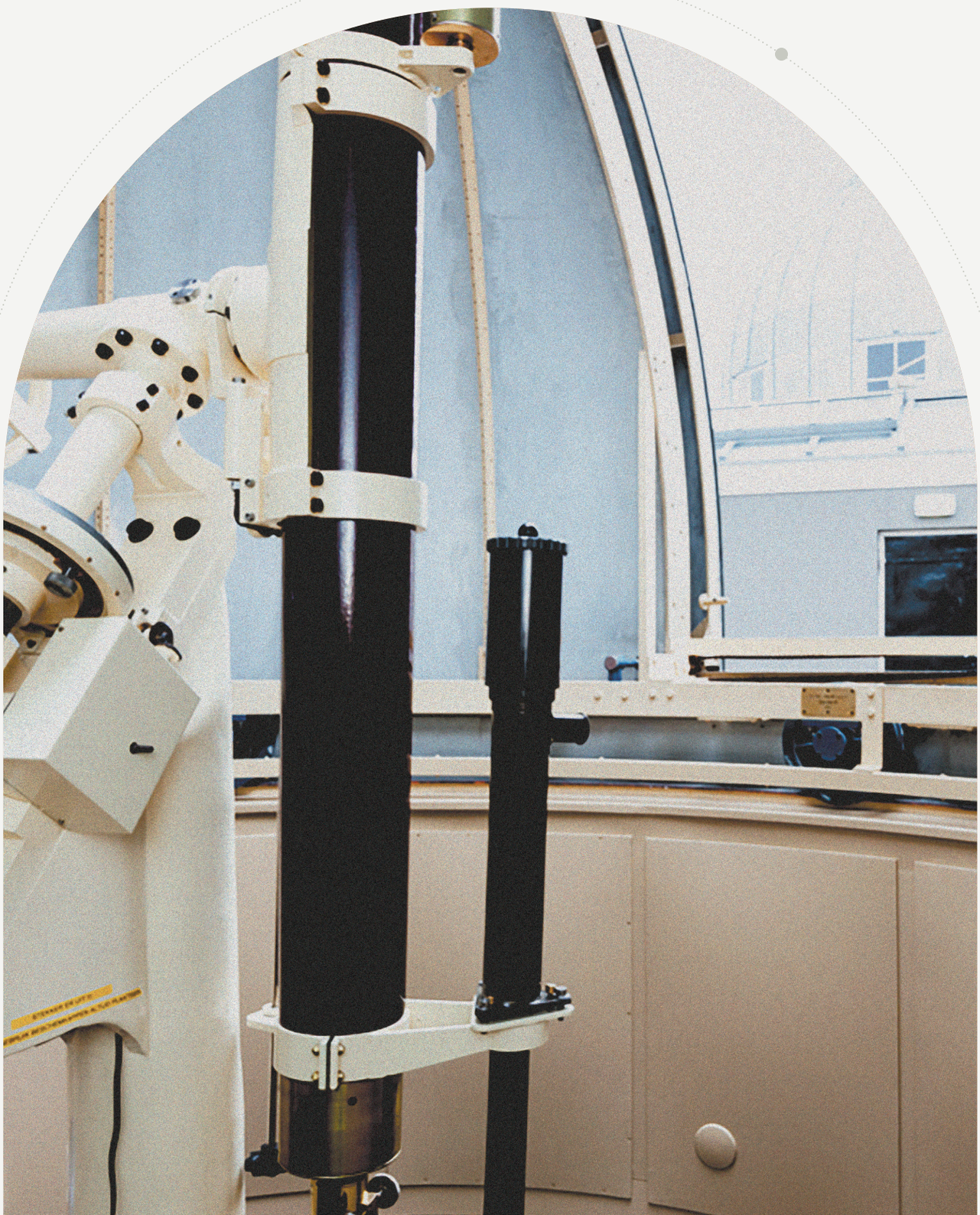
DECEMBER

Sinterklaas at the Leiden Observatory (online) [03]

Observatory Xmas Dinner online organised by the Social Committee [16]

Ewine van Dishoeck and Vincent Icke on group portrait on wall Achmea building in Leiden, by Rob Overmeer, Project “De Stijl van de Stad” [Dec. onwards]

2021: Another Year With Corona



The Path to Leiden

Credit: Pim Rusch

Three new staff members have joined us this year: Nienke van der Marel, Aline Vidotto and Mariska Kriek. Here they tell us about their research, what it was like starting at the Sterrewacht, and moving jobs in a pandemic. Interview by Emma Rigby.

Tell us a bit about yourself.

Nienke: I'm from the Netherlands. I moved to Leiden when I was 18 for my studies in physics and astronomy. I ended up doing a master's in astronomy instrumentation and then from there a PhD with Ewine van Dishoeck on planet formation with ALMA.

I got my PhD cum laude in 2015, then I moved to the University of Hawaii in Honolulu for my first postdoc. After that I moved to Victoria, British Columbia, where I did a postdoc at the NRC Herzberg Institute. Then I got the Banting Fellowship, which is like the Canadian Veni, and I took that to the University of Victoria. I started in Leiden as Assistant Professor last September. My expertise is still planet formation with ALMA, but branching out towards exoplanet studies.

Aline: I'm originally from Sao Paulo, Brazil. I did my undergrad and my PhD in Sao Paulo and spent part of my PhD working in the US too. I started as a postdoctoral scholar at the University of St Andrews, then I got a Royal Astronomical Society Fellowship there. Next, I moved to Geneva Observatory where I was an Ambizione Fellow. In 2016 I got a permanent job at Trinity College in Dublin, first as Assistant Professor, then as Associate Professor. Finally, I moved here as an Associate Professor.

In terms of science, my work is mostly theoretical and numerical simulations. In my PhD I started developing a new 3D implementation to study stellar winds and looking at how these winds and the stars could interact with exoplanets. Today my research is a mixed bag of different things: I have one foot in stellar physics and one foot in exoplanetary physics.

When I moved from Trinity to here, I brought three students and a postdoc with me. Another postdoc and student stayed behind. I'm hiring at the moment, so I hope to have another one or two postdocs and a student in September as well.

Mariska: Like Nienke, I did my PhD in Leiden, finishing in 2007. I worked with Marijn Franx but I also had another advisor in the US, Pieter van Dokkum, so I visited him quite a bit too. The title of my thesis was 'The Many Phases of Massive Galaxies'. I've branched out to quite a bit of other related topics since, but my focus is still primarily galaxy evolution. It's such a broad topic.

After my PhD, I went to Princeton as a Russell Fellow for three years, and then I spent a year as a Clay Fellow at the Centre for Astrophysics at the Harvard Smithsonian Centre. In January 2012 I started as an Assistant Professor at UC Berkeley. I got promoted to Associate Professor in 2014 and then to full, and this summer I moved back to Leiden.

Why did you want to come to Leiden?

Mariska: For me, it was a combination of things. I thought Leiden Observatory was a really great place to interact with people, and there is a lot of expertise in extragalactic astronomy here. At Berkeley we were a much smaller department. Another reason would, of course, be the facilities. I was also ready for a change. I think it's healthy to kind of reboot at some point and make a fresh start in a new environment. And of course, I shouldn't ignore the fact that I'm from the Netherlands and I have a kid, and I thought this would be a great place for my kid to grow up. I love biking around here. It's the thing I hadn't realised how much I missed. Berkeley is basically built on a hill, and with all the potholes in the street and the cars and everything else it was surprising that there were still so many people biking there.

Nienke: That's a complicated question. First of all, I didn't have a permanent position in Canada. I was on my third postdoc looking for a permanent job. Originally, I didn't want to come back to Leiden because I was very happy in Canada. I really liked the lifestyle there. I lived in British Columbia, so I was in the middle of the mountains and lakes. I also felt like I could really contribute to the Canadian astronomy community because my field didn't really exist there yet. I was very close to getting a faculty position there but I didn't get the offer, and then with the pandemic it was clear there were no jobs in Canada last year. Literally no jobs. I started to look in other places and Leiden was definitely high on my list. I would say that's the reason I came, and I certainly don't regret it in any way. Leiden is a fantastic place. I realised how much I had missed being in a big department, with so much expertise and so much diversity in people. It's very friendly. It's very nice to be back but I do miss the mountains. I love biking the hills in Victoria, so I don't share your feelings there Mariska!

Aline: My decision was research based. I really enjoyed working at Trinity College. It was a great place where we had access to really good students. But it was the first time I was in a physics department. I had always been in astronomy groups before and I missed the connection with other astronomers.

Ireland, unfortunately, does not have a continuous national funding programme for basic science, and I thought it would be hard to have a healthy research group in the long term, especially after the end of my current ERC grant. So, I started looking for jobs in other places. I wasn't in a rush, so I could pick the best opportunities for me. Leiden really stood out because it has connections with so many other nearby institutes like SRON, ESTEC, and Amsterdam. I also feel the funding situation here is a lot healthier than what I had in Dublin.

In terms of research, it's nice to connect my work in the exoplanets group with what other people around are doing. I hope that we'll be able to meet more frequently soon because

I miss having discussions over coffee where you suddenly learn about something completely unrelated to what you're doing and find common ground in different areas.

What was it like moving in a pandemic?

Nienke: I moved at the end of August and there was almost no pandemic at that time. I didn't even need to get a test to move. I was already double vaccinated. The only thing related to it was that I had to go to Utrecht to register my Canadian vaccination.

Aline: For me the challenge was that I could not come and visit before I moved. I had to base everything on previous visits I'd made to the Netherlands. There were a lot of regulations in Ireland for travellers coming back and I would have had to quarantine in a hotel. I wanted to visit and see houses before I actually moved, so not being able to do that was the worst bit.

Mariska: It was quite complicated for me because I had to move my family and sell our house. We were in temporary housing for a long time and it was difficult to sort everything out. I definitely felt a little lost in the summer. If you're a foreigner and you come here, then you're connected to the International Office. But if you're a Dutch person, everyone thinks you know how everything works with getting registered etc., and it's not that easy.

Nienke: It's not really pandemic related, but I had very much the same issues and the same complaint that if you're a Dutch person who returns to the Netherlands after cutting the ties you have to go through – all the same hoops that foreigners have to go through – which feels really silly. I had to register with my parents at first, because otherwise I couldn't get my DigiD or health insurance. Luckily I was able to do it, but not everyone still has their parents or relatives available.

What's it been like doing science during the pandemic?

Nienke: The first one and a half years, when I was in Canada, were good for my publications and my productivity because I had nothing else to do. Mental health wise though, it was definitely not good. You could say I got this job partially because of the pandemic because I worked so hard on preparing for the job interviews. But again, I don't think that's a good thing.

When I first arrived back it was amazing because there were already less restrictions here than in Canada. September and October were great. I could even travel: I went to a conference, I went to visit another institute in Europe, things that I hadn't done for two years. But then of course eventually everything closed down again and I went back into a bit of a negative spiral. I don't know what the global picture is for science. I don't think we will really know that until a few years from now, when we look back.

Aline: I think I'm one of those weirdos that actually had a boost in productivity in the pandemic. Mainly because I was able to drop a lot of administrative tasks and spend more time doing research. Working remotely also helped me concentrate more on it. I can't complain. There were a lot of people who had to face a lot more challenges than I had.

Mariska: In Berkeley it was rough because I was the undergrad advisor and this job just became even worse than it already was. It was also hard not having childcare for a very long time, having no support and being so far away. I agree with Nienke that the first few months here were awesome and I actually got quite a bit of research done. All those things that I really wanted to do for years, and I finally found some time for. Then the pandemic got worse again, of course, and then we were home for a month because of COVID and school closures.

What were your first impressions of Leiden?

Aline: I came from a place with really strong restrictions so when I arrived in the centre of Leiden and there was this sea of people all sitting and having drinks it was crazy. But after the first shock, I really liked it. I think it's

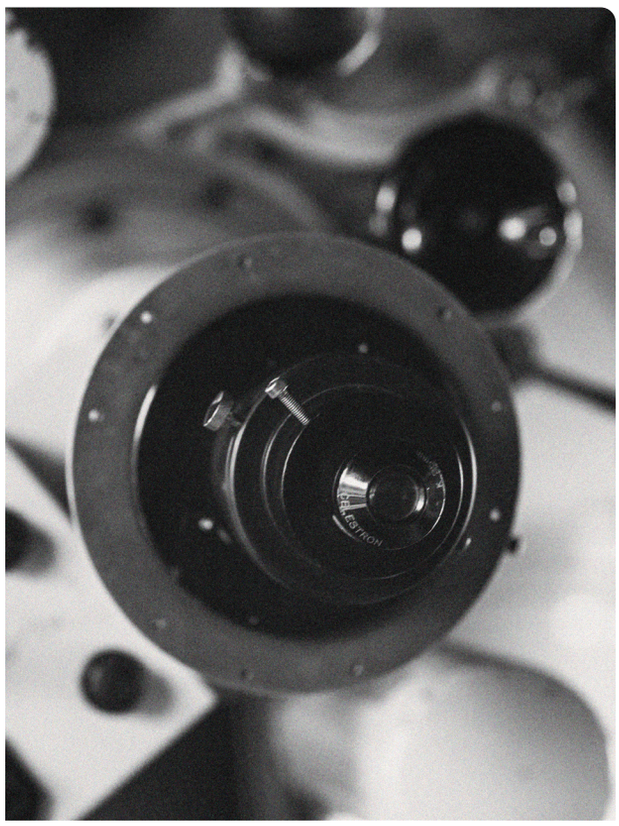
a lovely place. I can't wait for the pandemic to be over so my family can come and visit. I really like the convenience of being close to an airport that travels everywhere with direct flights.

Mariska: Dutch people don't realise that privilege. They just don't. I never thought about it before I moved abroad and I still always lived near an international airport.

Aline: I'm planning my conferences and travels this year and every single place I have to go I can take one flight. That's really good. Helps a lot. I missed being in mainland Europe.

Mariska: But it's so sad that we're all new people and there's all these people already at the observatory, but everyone is just stuck at home.

Nienke: Yeah, I still feel a bit like I haven't really started. I haven't had the full Leiden staff experience yet. A few times there was a glimpse of it, like when we had the barbeque and the dinner that we had together with all the new staff members. That kind of felt like normal.



What are your goals for your work in Leiden?

Mariska: My goal is to build a new fun effective group at Leiden and do great science. I cannot wait to get my hands dirty on the James Webb data. It will be a very exciting time.

Aline: Well, I have a lot of science to do that I promised the European Commission I would deliver! We also have a CubeSat to look at specific exoplanets which are evaporating. It was successfully launched in October last year. My responsibility is to help the observers on the team with some data interpretation and modelling of what we're going to see. I'm looking forward to starting working with this data, which will hopefully start coming in the next month or so.

The other thing I really want to do here, as well as collaborating with people in Leiden, is to work with other people in the Netherlands. There are a lot of great groups here and I'm looking forward to getting to know more of the science community.

Nienke: My goals are not too different from the others. I also want to build a large group. I already have two PhD students and I'm hiring a postdoc, starting September. And I've already tried to create a sort of collaborative group with various other students from other supervisors for weekly discussions.

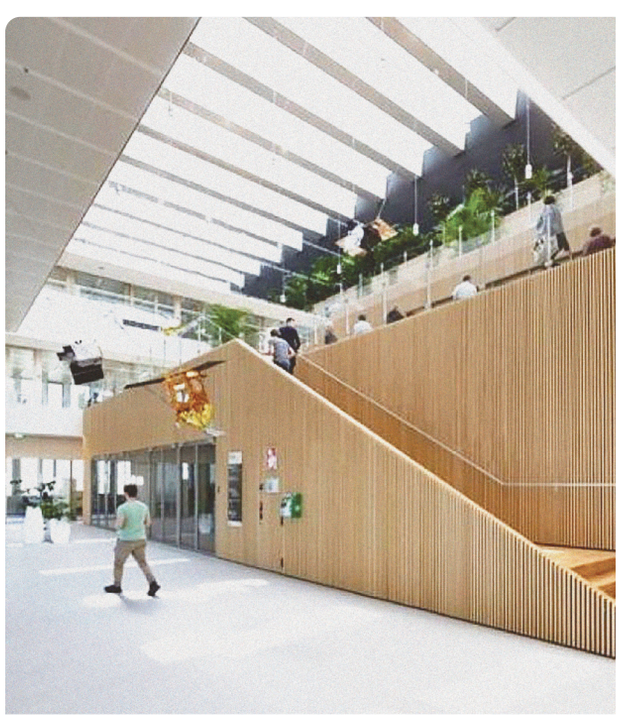
I want to encourage more collaboration in my field, because right now protoplanetary disks are still widely separated from exoplanets and exoplanet atmospheres. I'm really trying to build those bridges in Leiden, but also with other institutes in Europe.

I also want to do more outreach. I love outreach. I haven't talked about science in Dutch for a long time, so it's a good challenge. In the longer term, maybe 10 to 15 years from now, I would like to get involved in some instrument development. That sounds really cool, to contribute to future science.

SRON, NWO-I Netherlands Institute for Space Research moves to the Bio Science Park

Following years of preparatory activities and the construction, the new laboratory of SRON has been opened at the Bio Science Park just opposite to the Leiden Sterrewacht, strengthening the relations between SRON and the Sterrewacht. It is an open, new building with all necessary technical facilities for SRON (clean rooms, labs, mechanical construction equipment and lithographic equipment) and is optimised to reduce the environmental load as much as possible. There is also ample room for combined meetings and some of the Leiden students, collaborating with SRON, spend most of their time at this new building.

Key to collaborations is the combined research between SRON staff and staff/students of the Leiden Sterrewacht. Of the three positions created to strengthen this collaboration two positions have been filled. The position on exoplanes is filled by a tenure track staff member (Aline Vidotto) and the position on high-energy astrophysics/Athena it was agreed to fill this initially by an Oort fellowship (Konstantinos Migkas). In addition to the position of dr. Kaastra as professor by special appointment, an increasing number of SRON staff have a guest appointment, enabling them to oversee masters students. In addition, information about colloquia is shared. In the areas of exoplanets and clusters of galaxies, both areas have been strengthened with combined team meetings. In the future this will be further expanded with the LISA mission in which the Sterrewacht participates in a SRON led proposal for large scale research infrastructures.



The SRON building next to Leiden Observatory. Credit: SRON/Ivar Pelo

Unravelling the hot history of galaxy and structure formation

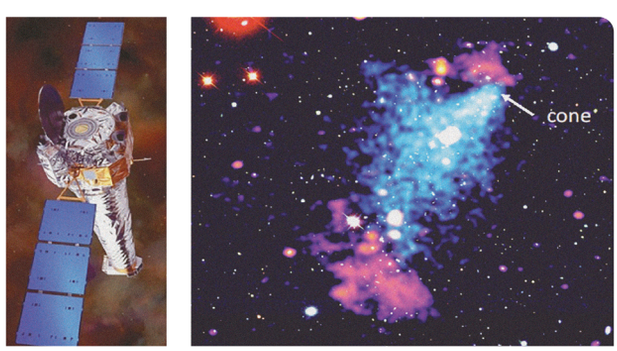
Over the past decade, our ability to model realistic galaxies in large-scale computer simulations has witnessed a huge leap. One of the important things we have learned from these updated models is that the hot, diffuse atmospheres of galaxies (or so called circumgalactic medium, CGM) play a critical role in the life and evolution of the stellar population hosted within the same halo. Direct observations of these hot atmospheres are, with very few exceptions, outside the sensitivity limits achievable with current X-ray telescopes. By combining the extensive expertise in galaxy formation simulations at Leiden Observatory, together with the detailed X-ray spectroscopy modelling packages and involvement in future X-ray missions that are cornerstones of SRON's science agenda, we hope to develop new strategies for unveiling the precise properties of the CGM over the next decade. In particular, the groups of Joop Schaye at Leiden and Aurora Simionescu and Jelle Kaastra at SRON are collaborating closely in the supervision of two PhD students who are producing realistic predictions of what future observations with X-ray telescopes might look like based on the most recent models of galaxy evolution.

The connection between particle acceleration and gas dynamics at radio and X-ray wavelengths

A team led by Xiaoyuan Zhang (PhD student in Leiden) and staff members from the Leiden Observatory and SRON have studied the target ZwCl 2341+0000 in great detail. This merging galaxy cluster had previously shown a puzzling mismatch between its properties at X-ray versus radio wavelengths. Namely, a part of its southern radio shock (also known as "radio relic") was associated with a clear X-ray brightness jump, whereas the other part of the radio structure surprisingly did not correspond to any X-ray features.

By combining data from the Chandra observatory (where SRON is one of the principal investigators) together with data from GMRT 325 MHz and JVLA 1.5 and 3.0 GHz images, where the Observatory has expert knowledge, the team could investigate this problem further by combining deep X-ray data with new radio spectral maps of this object. They found that the actual location of the shock, both in X-rays and radio, was farther out from the cluster centre than the initial, shallower data had suggested — the mismatch reported previously was resolved, and the new observations of ZwCl 2341+0000 now support the connection between radio and X-ray shocks seen in other merging clusters.

The team further discovered that the northern subcluster is in a perfect cone shape, with a ~ 400 kpc linear edge on each side. This type of conic subcluster had been predicted by simulations but was observed here for the first time. The likely reason such a structure is very rare is that it represents a short-lived transition stage during the merger. The team also discovered a long, narrow gas trail attached to the apex of the cone, which illustrates the more complex plasma physics and dynamics taking place during cluster collisions.



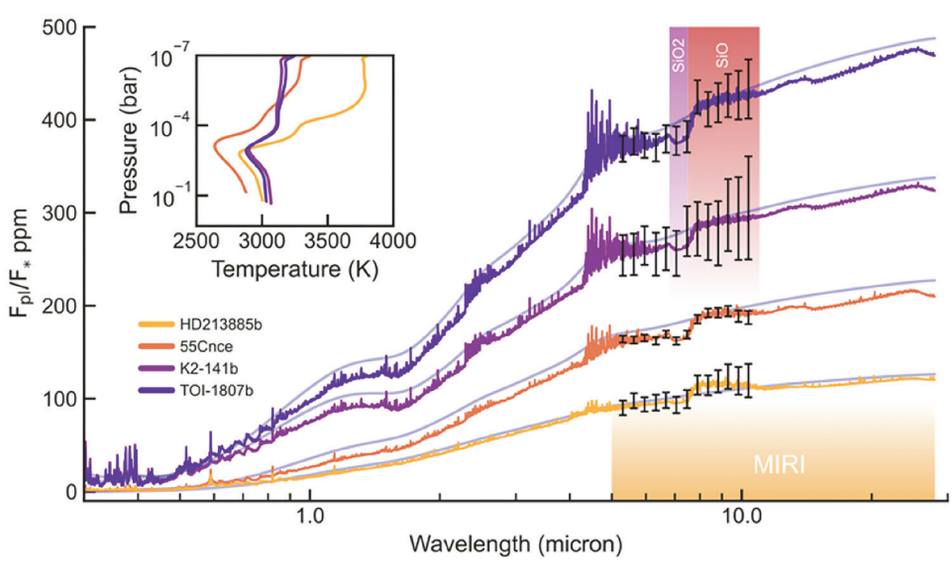
A long observation with Chandra (left) revealed a clear cone-like shape in X-rays (right panel) (X-rays in blue and JVLA in purple and pink, and objects in the visible are in red, yellow and white). The star at the top left is a Mira-type variable (AD Psc). Credit: X.Zhang et al. 2021

Connecting exoplanet atmospheres to the formation of planets

Leiden observatory is well known for its research on planet formation. The Ariel space mission, for which SRON leads the calibration work package, has as one of the major goals to constrain planet formation theories from derived exoplanet atmospheric compositions. A strong collaboration is set in place between the group of Nienke van der Marel (Leiden Observatory, working on protoplanetary disk characterization) and Michiel Min (SRON, working on exoplanet atmosphere characterization) to study specifically how we can constrain planet formation theory from elemental compositions of exoplanets. There are weekly meetings specially focused on this interdisciplinary work where connected research from the two groups is discussed together with recent publications from the scientific literature. The combined expertise on exoplanets and protoplanetary disk research allows especially the PhD students to put their work in a much broader context and gain a more complete overview and understanding of the scientific literature.

Detectability of the atmospheres of lava worlds

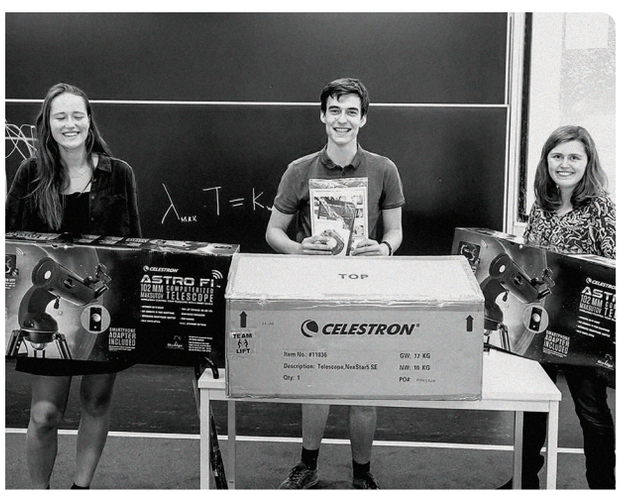
Some rocky exoplanets are so close to their host star that the surface melts and evaporates to create an outgassed atmosphere. These so-called lava worlds are the topic of the work done by the PhD student Mantas Zilinskas (Leiden Observatory) under the supervision of Yamila Miguel (SRON/Leiden Observatory). Within this work, the team computed the observable signature of these planets with the MIRI instrument on board JWST. Several key molecules are identified that can be observed with JWST and provide important constraints on the crust composition of these lava worlds. For this several crust compositions were studied. Collaboration within the Guaranteed Time Observational (GTO) program of MIRI/JWST between Leiden and SRON is already very active. Specifically based on the work on lava worlds a successful General Observing (GO) proposal was approved on which both Zilinskas and Miguel are co-I's.



Synthetic emission spectra of four selected lava planets with outgassed silicate atmospheres. Corresponding temperature profiles for each planet are shown in the inset. Error bars are simulated for the JWST MIRI LRS mode. Shaded SiO (9 μm) and SiO^2 (7 μm) are likely to be the strongest characterizable features of silicate atmospheres (taken from Zilinskas+ 2022).

Nederlandse Sterrenkunde Olympiade

The Nederlandse Sterrenkunde Olympiade was held in Leiden from 9–11 June 2021, organised by Harold Linnartz, Christiaan Buchem and Lucas Stapper. After a national preliminary round, ten candidates were selected to come to Leiden for three days. These included students from VWO levels 5 and 6, six women and four men from all over the country. In the Old Observatory in Leiden they participated in a number of master classes, given by professors and teachers of the Leiden Observatory: Ewine van Dishoeck, Henk Hoekstra, Koen Kuijken, Huib-Jan van Langevelde, Vincent Icke, Frans Snik, and Anthony Brown. The selected students had to do six challenging assignments on astronomical topics that were discussed during the master classes, with prizes for the best answers (a number of beautiful telescopes) that were presented to the three prize winners, with a clear winner in the first place: Kevin van Dijk from the Stedelijk Gymnasium in Nijmegen.

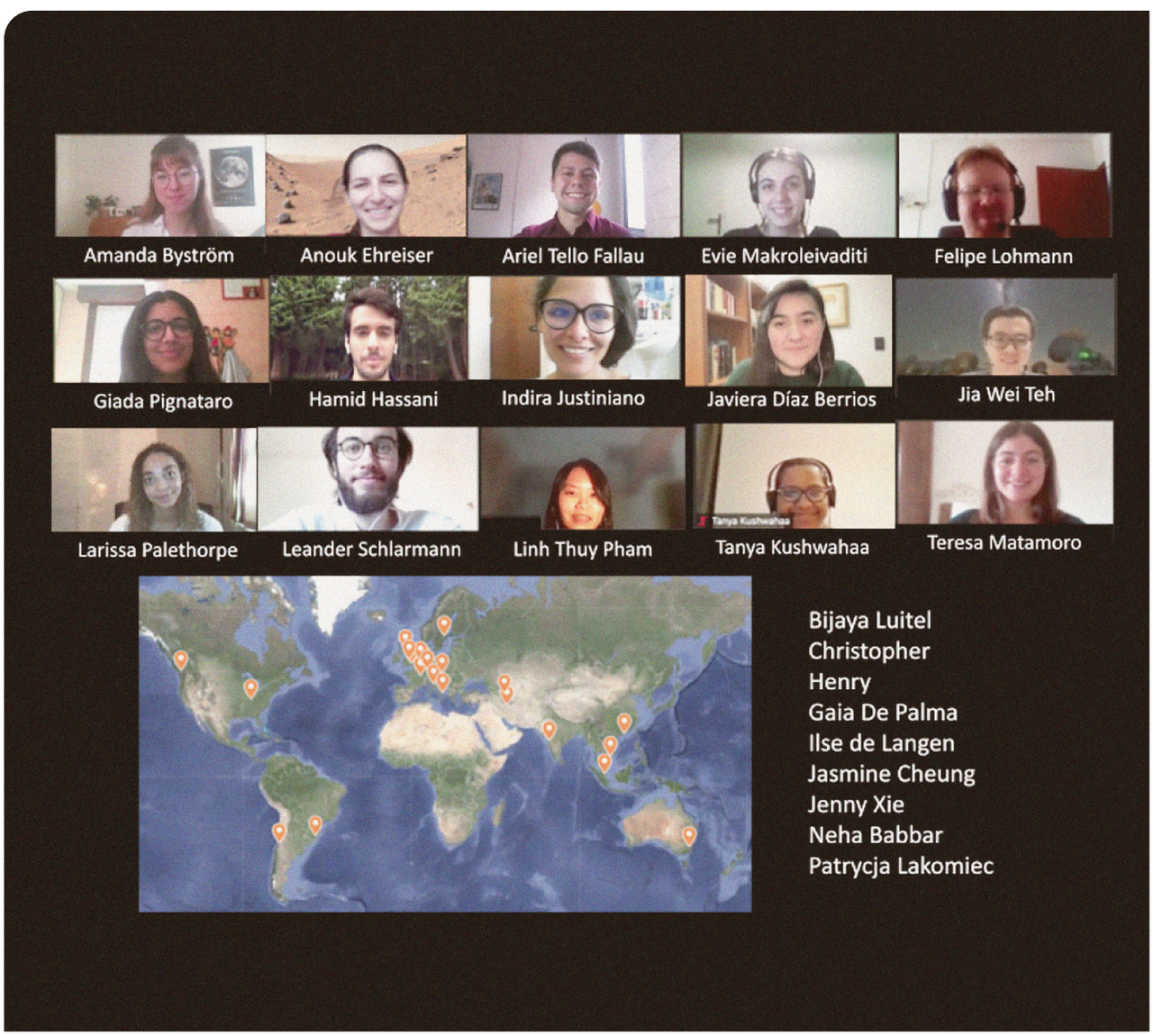


The three winners with their telescopes. Credit: Pim Rusch

All the entrants in the Olympiade. Credit: Pim Rusch

LEAPS

The Leiden/ESA Astrophysics Programme for Summer Students (LEAPS) was a 10-week program held online in 2021. 23 students from across the world conducted research projects with Leiden and ESA/ESTEC astronomers on topics ranging from comets to galaxy clusters. In addition to their projects, the students participated in a weekly online lecture and workshop series joined by ASPIRE (Astrophysics Summer Program for International Research Experience) students at the University of Amsterdam. Lectures were designed to introduce the students to the range of scientific research being done in Dutch astronomy, while workshops equipped the students with the skills of an astronomer (including Python programming, databases, writing, preparing a CV, giving presentations). Additional activities included a virtual tour of ESA/ESTEC, events in gathertown, and an online escape room.

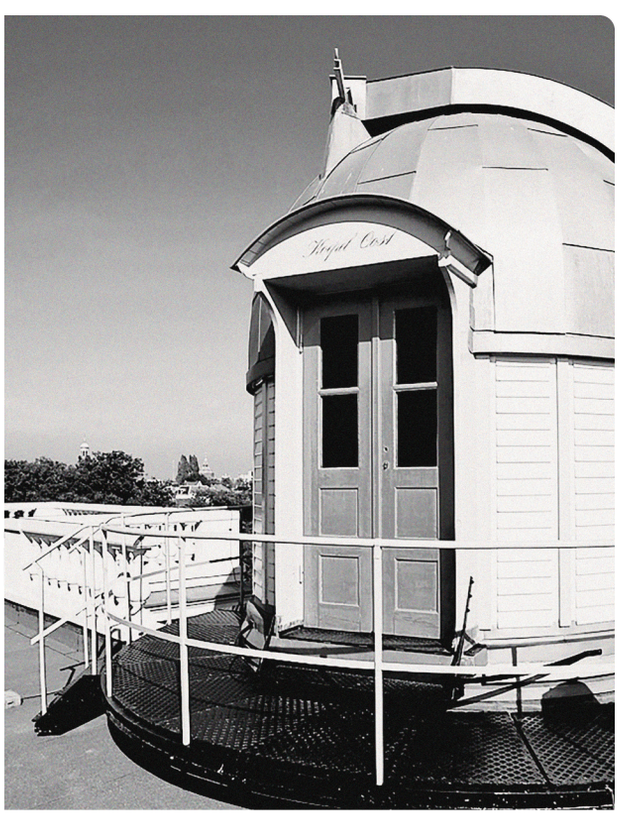


Teaching and Corona

Prof. dr. Harold Linnartz
Director of Studies Astronomy

Once again Covid-19 dictated the way teaching had to be organised in 2021; online, with exceptions for exercise and practical classes, or in a hybrid setting, with or without a maximum number of students per lecture room, with or without face mask when walking and/or sitting … and regulations steadily changing over the year, depending on governmental decisions typically announced during Tuesday and Friday evening press meetings. But let's start at the beginning.

In January, the Covid-19 health situation in the Netherlands became so critical that a curfew had to be set. Daily life was completely disrupted. The vaccination program slowly started. International travelling was forbidden. Elementary and high schools as well the Universities offered remote teaching. Restaurants were closed, people met online, the highways were empty and so were our University buildings. Not the best setting for starting a new semester and definitely not when you just arrived as a lecturer to start the course 'Praktische Sterrenkunde' (PS) for some 100 first year students of astronomy. This was the case for our new colleague Ana Monreal Ibero. But as the saying goes 'waar een wil is, daar is een weg', and the Observatory managed to get special permission for our new students to work at the Old Observatory during curfew, with two students at the time, night after night, for months. In this way our learning goals could be realised, not only for PS but also nearly all other bachelor and master courses. It definitely helped that from early 2021, we were allowed – finally – to use ZOOM as a teaching platform. In parallel, lecturers, TA's, students and educational support staff worked hard to deal with the many boundary conditions that had to be faced. Travelling to La Palma for the Astronomy Lab and Observing Project (ALOP) was not possible, but Reynout van Weeren managed to have local staff performing the observing projects of our 2nd year students. Bachelor and Master research projects continued, with limited but regular access to the Huygens and Oort buildings for students to speak in person to their supervisors, or with full access when special equipment was required. In one case, students were allowed to build a full optical setup in their bathroom at home to study polarisation effects. Numerous were the initiatives that were taken to keep teaching going.



The overall situation improved late in the spring semester when measures were downscaled all over the Netherlands, and in August we could celebrate the bachelor graduation of some 45 students, accompanied by family and friends, in the festive settings of the Corpus Congress Centre. Over summer, it became clear, unfortunately, that the infection numbers were rising very quickly again. In July it was decided that in September we would be teaching in hybrid mode for a maximum of 75 persons with parallel streaming and recording. The logistical impact of this decision was enormous, given the lack of sufficient lecturing space and limited WIFI capacity within the faculty for the many students working on location to bridge between lectures and exercise classes. Fortunately, the educational office had managed to upgrade all lecture rooms in the Huygens building with state-of-the-art (and easy to use) recording facilities. Also, never before 2021 have we supported

our students (over 100) with so many TA's, to guarantee assistance in small working groups. With the start of the new semester, we asked all our international masters students, many of them living temporarily abroad to come back to Leiden again, to intensify their on spot supervision. Even under Covid-19 conditions, more than 50% of them entered a PhD program, in Leiden or at institutes elsewhere, which shows that even under Covid-19 conditions Leiden Observatory has managed to keep the high quality of its research projects.

Did we learn from the online teaching during Covid-19 ? Yes. Students love(d) the possibility to re-watch lectures using the recordings. The chat during a lecture was and is highly appreciated, as TA's can address questions without the need to interrupt a lecture. And 'multimeter' and other platforms offered another dimension to interactive teaching. We also learned, unfortunately, that many students considered the online teaching to be so convenient, that this became a valid alternative for real lectures, also when the impact of Covid-19 substantially decreased more recently. This affects academic skills that are not tested during an exam, in particular 'academic life' that takes place at the University and not behind a computer screen at home. For the years to come, it will be important to cherish what we have learned from teaching during Corona, and at the same time we should guarantee that our students find their way to our offices as easily as they did before the pandemic started.

The Observatory Wellbeing Committee: Monitoring Mental Health at the Observatory

Yamila Miquel on behalf of the Wellbeing Committee

Our committee was formed in March 2020 in response to the COVID-19 pandemic and social distancing measures (formerly called the Social Support Committee). Throughout these two years, the committee has evolved and taken action not only on direct COVID-related issues but also in response to a present need from our community to deal with mental health issues associated with isolation and concerns on our academic careers, communication between colleagues, peer pressure, and impostor syndrome, amongst others.

Because of this evolution, the name of our committee has changed and is now called **The Observatory Wellbeing Committee**.

While we continue to monitor staff and student wellbeing through short anonymous surveys sent out to the observatory every month, we have also organised a Buddy system, weekly Mindfulness sessions and maintain information on our local website. For this upcoming year, we are planning a series of workshops to improve our wellbeing and raise awareness of these issues so crucial for our health, happiness, motivation, and productivity.

The James Webb Space Telescope

Marijn Franx

The successful launch of the James Webb Space Telescope was one of the highlights (literally and figuratively speaking) of the year. Leiden astronomers have been involved for more than 20 years in the design and building of its instruments: the MIRI instrument had a significant hardware contribution in the form of the medium resolution spectrograph which was built in the Netherlands with contributions from astronomers in Leiden, Groningen, Amsterdam and the NOVA optical infrared Laboratory. The wait between the building of the instrument and the launch was more than 7 years, but we are looking forward to very exciting results. Leiden astronomers were also involved in the building of the NIRSpec spectrograph, which was coordinated from the nearby ESTEC and built by industry from all over Europe. Leiden astronomers have been very successful in getting observing time on the Webb to perform studies ranging from exoplanets to black holes to very dusty galaxies to early massive galaxies to the faintest highest redshift galaxies.These observations are expected to start in the summer of 2022.

NASA technicians lift the James Webb Telescope, using a crane, and move it inside a clean room at NASA's Goddard Space Flight Center in Greenbelt, Maryland. The scientific successor to NASA's Hubble Space Telescope, Webb is the most powerful space telescope ever built. Credits: NASA/Desiree Stover

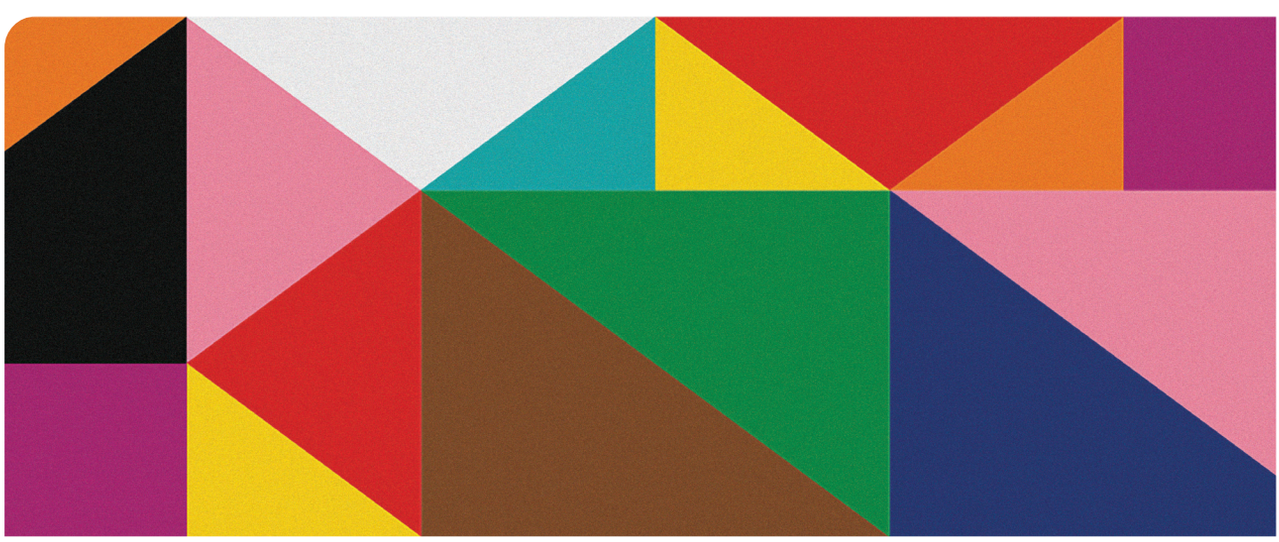
Equity, diversity and inclusion

Sanjana Panchagnula on behalf of the EDI committee

For Leiden Observatory's Equity, Diversity, and Inclusion (EDI) Committee, 2021 began with the return of the biennial EDI climate survey with nearly 200 responses from students and staff at the department. The results from this survey will directly determine which tasks the EDI committee tackles and prioritises in the coming year. In 2021, the committee grew even further and now includes Master's students, enabling us to better extend our efforts to reach everyone in the department. One instance of a positive push for inclusivity is the active role the committee played in providing gender neutral toilets and sanitary products across the Observatory. In the past year, the committee has had increased ties with EDI efforts at the faculty level, university level, and national level. As one of the only departments at Leiden University with a dedicated EDI committee, we have seen a lot of interest and praise from other departments and faculties wishing to emulate the work being done at Leiden Observatory.

In September, the EDI committee welcomed Prof.dr. Edwin (Ted) Bergin from the University of Michigan to present a workshop on faculty recruitment for diversity and excellence, which prompted an important discussion amongst senior leadership on how to adapt our hiring processes to reflect best practices. As a result, this year's PhD hiring process was altered to ensure that at least 10% of all invited applicants came from developing nations, and all potential supervisors were encouraged to refer to a list of non-biasing questions provided by the committee in keeping with best practices when interviewing candidates.

2021 also saw lots of progress in EDI on a larger scale. The Netherlands Astronomy Equity and Inclusion Committee (NAEIC) hired its first EDI Officer, Dr. Tana Joseph, who will work directly alongside all Dutch astronomy institutes to implement and streamline best practices in EDI. To cement leadership commitment to EDI efforts, the director of our department, Prof. Huub Röttgering, attended a two-day "EDI masterclass" workshop along with EDI committee members and NAEIC representatives Sanjana Panchagnula and Dr. Pedro Russo. And, following an initiative led by Dr. Joseph Callingham, the committee played a key role in successfully urging the scientific journal Astronomy and Astrophysics to modify their retroactive name-change policy to create a more equitable academic publishing environment for minorities such as the trans community.



Research Highlights

Measuring the Cosmic Ray Ionization Rate in NGC 253

Jonathan Holdship

Cosmic rays play a vital role in the interstellar medium, heating and ionizing gas to drive chemistry and dynamics. In fact, much gas-phase chemistry in the ISM is driven by chains of reactions that begin with cosmic ray ionization. It is therefore important to measure the cosmic ray ionization rate (CRIR) when studying an object.

NGC 253 is a nearby, prototypical starburst galaxy. A large portion of the star formation in this galaxy appears to take place in large, dense structures which are similar to giant molecular clouds (GMCs) in our own galaxy. However, these GMC-like objects are hotter (>50 K) and more massive than GMCs in the Milky Way. Understanding the physical conditions of these objects will go a long way to extending our understanding of how star formation proceeds in conditions that are much more energetic than those found locally. Measuring the cosmic ray ionization rate in these GMCs is a large part of that.

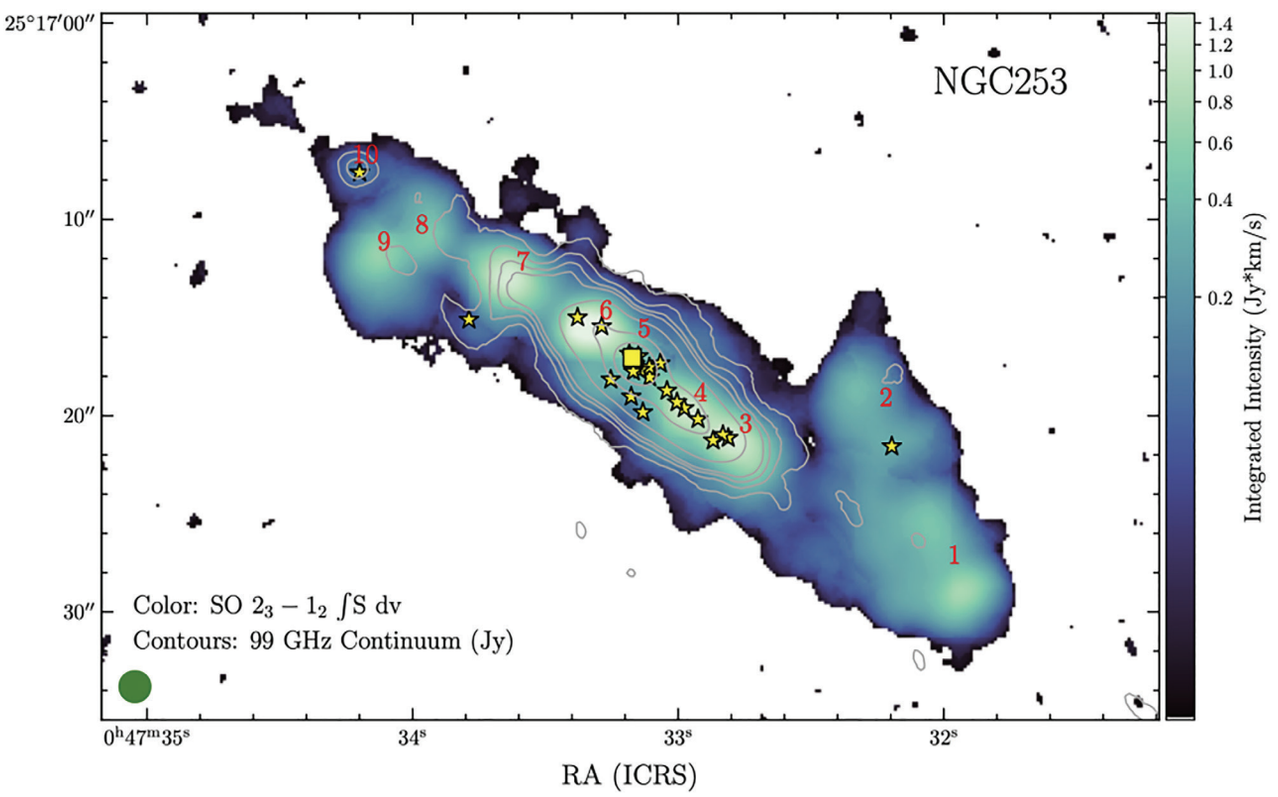


Figure 1: SO 2_3 – 1_2 moment 0 map of NGC 253 overlaid with contours showing the dust emission. GMC locations are indicated by red numerals.

We have observed the central molecular zone (CMZ) of NGC 253 as part of the ALCHEMI ALMA large program which has produced a comprehensive spectral survey of the region giving an immense amount of data on the molecular emission from these GMCs. Early work by ALCHEMI using C_2H, HCO^+ and HOC^+ found that the CRIR is extremely high in the GMCs, at least three orders of magnitude higher than in the Milky Way. However, we were not able to constrain the value with any particular accuracy beyond this lower limit and concluded a much more accurate molecular probe was required.

A new probe of the cosmic ray ionization rate

In order to better measure the CRIR, we needed both a model and an observable which was sensitive to that rate. For the model, we used our chemical code UCLCHEM to produce chemical abundances from input physical parameters and then passed those to RADEX (a radiative transfer code) to produce model intensities of various molecular lines. In this way, the chemical model encodes the effect of cosmic rays on the abundances of molecules and the radiative transfer code produces outputs which can be directly compared to our data.

In terms of observables, ALCHEMI observed molecular lines from a vast array of molecules. However, since different molecules trace different conditions, it was important to find molecules that trace the bulk of the GMCs and had abundances that are more sensitive to cosmic rays than other effects. Photon dominated region models showed that both H_3O^+ and SO are destroyed under high UV fluxes such as in the irradiated edges of the GMCs. Thus, any emission from these species is likely to come from the UV shielded bulk of the GMCs. Moreover, Figure 2 shows that since SO is destroyed by cosmic rays and H_3O^+ is efficiently formed, their ratio is extremely sensitive to the CRIR making them a fantastic probe of this quantity.

With this groundwork in place, we were able to perform a Bayesian inference of the cosmic ray ionization rate in the GMCs of NGC 253 incorporating all of our uncertainty from our lack of knowledge about the total column density, the ortho-para ratio of H_3O^+ or even the metallicity of the galaxy. As a result, we find the CRIR in these regions is in the range 1 to 80×10^{-14} s^{-1}; roughly 3 to 4 times the Milky Way value. We were further able to verify that our model could fit all previously measured cosmic ray tracers in our data and that X-ray irradiation could not be used to model the data despite the fact it is typically invoked as an alternative to high cosmic ray ionization rates.

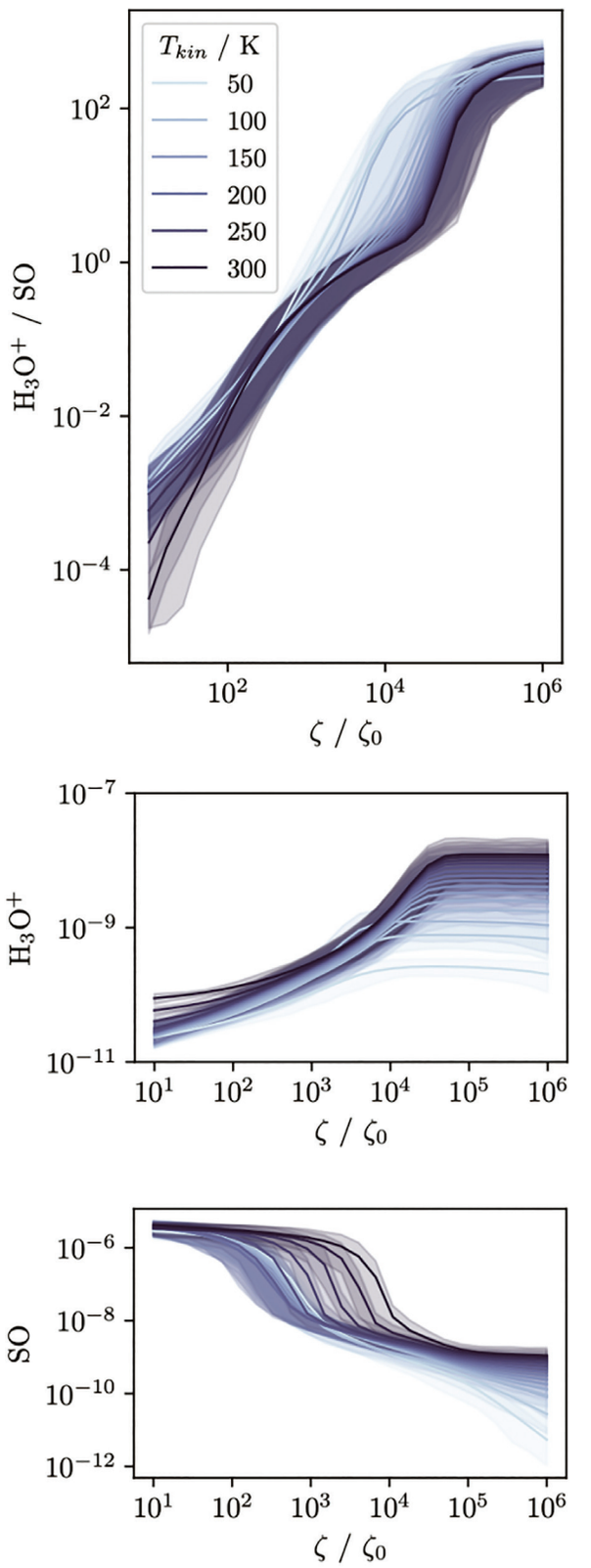


Figure 2: H_3O^+ and SO abundances as a function of CRIR alongside their ratio. Different colours indicate different gas temperatures and the shaded region shows the variation over different densities. Both overall show the ratio is strongly dependent on the CRIR but only weakly dependent on other parameters.

Future Outlook

This is an important measurement due to its accuracy and comprehensive validation. However, it is only a first step. The measured CRIR in these GMCs should be linked back to the physical processes that are ongoing in the regions. For example, several supernova remnants have been detected in the CMZ of NGC 253 and there is some evidence to suggest the CRIR in each GMC is proportional to the distance to these remnants. Therefore, we need to calculate the cosmic ray production of these supernovae and attempt to understand how that links to the average rate of ionization that we are measuring.

That work will be boosted by a more global view of the CRIR in NGC 253, measuring it throughout the CMZ rather than just in a few GMCs. However the inference process for this work was long and time consuming, not least because the model takes between several seconds and a minute to run. The many iterations required for the full inference results in over 500 CPU hours of calculation per GMC which becomes difficult when we wish to measure many positions in the galaxy.

Fortunately, a spin off result from this project will ameliorate this. The chemical model results were stored as they were produced for the GMC measurements which has resulted in a large dataset of chemical abundances as a function of the input parameters. We can use these to train a neural network to replicate the model, meaning the future CRIR measurements on everything from the Milky Way's ISM to GMCs in other galaxies can be done with ease. This will allow us to measure the CRIR in the whole CMZ and beyond.

Towards molecular complexity in birth places of stars: Formaldehyde formation from carbon atoms reacting with water ice

Thanja Lamberts

Formaldehyde in interstellar ices

The surface formation of formaldehyde (H_2CO) has – up-to-now – been thought to occur in the later stages of molecular clouds in which stars are born. This is a direct consequence of the hydrogenation of carbon monoxide (CO) on top of cosmic dust grains, and solid-state CO is only abundantly present towards the end of the cloud lifetime. Formaldehyde, from a chemical perspective, is the simplest so-called carbonyl compound: a molecule containing a carbon atom double-bonded to an oxygen atom. Containing both carbon and oxygen, it plays a central role in the formation of complex organic compounds and it is one of the sources for the formation of prebiotic molecules in space. For instance, the reaction chain that starts with H and H_2CO can eventually lead to the formation of the simplest sugar, glycolaldehyde (Chuang et al. 2016).

Carbon-atom addition reactions

At the core of complex organic molecule synthesis in space is the formation of bonds with a C atom, which, in turn, depends upon the main reservoir of carbon. In fact, one way for bottom-up chemical reactions to lead to molecular complexity in interstellar ices is via successive addition of carbon atoms to already existing molecules (Charnley et al. 2001). This naturally poses the question whether the addition of a carbon atom to the water molecules, present in interstellar ices, could directly lead to the formation of formaldehyde: C + H_2O to H_2CO. The formation of formaldehyde in this way would require a two-step reaction, where first C is inserted in H_2O, forming HCOH, followed by a hydrogen atom migration leading to H_2CO, see also Figure 1.

Both reaction steps have been studied previously in the gas phase and in an argon solid-state matrix. Those studies show that a large amount of energy (several thousand Kelvin) is required for the reactions to proceed, which in cosmic nebulae at a temperature of 10 K, is not available.

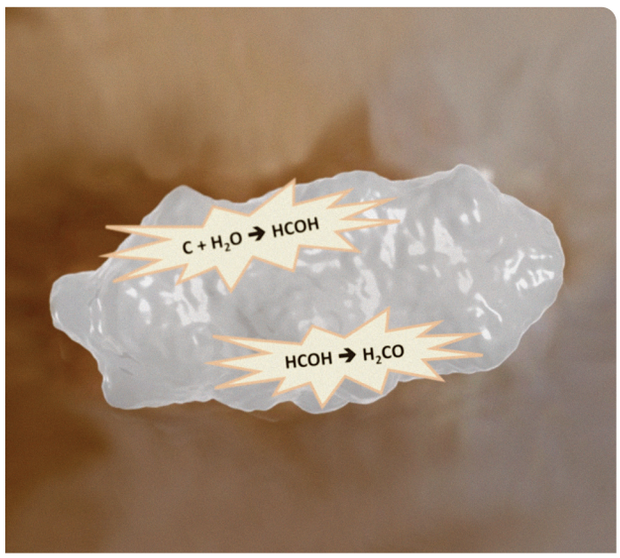


Figure 1: The reaction sequence starting with carbon atoms atop amorphous solid water might lead to the formation of formaldehyde.

Water-catalysed reaction on ices

We have investigated whether a reaction mechanism exists that circumvents this. To this end, we computed two mechanisms on a water ice surface: (1) the conventional, high-energy route and (2) a water-assisted or concerted pathway. The so-called “transition state structures” are depicted in Figure 2 that shows the geometric chemical structure of the intermediate complex between reactants and products.

Initially, for both mechanisms, a complex is formed between a carbon atom and a water molecule. That molecule, however, is bound to its neighbouring water molecules and this is taken into account in the study of mechanism 2. Hydrogen bonds act simultaneously as donors and acceptors of protons (positively charged hydrogen atoms). As such a pseudo-transfer of protons from the oxygen atom of the formed complex to its carbon atom can be carried out. This coordinated transfer of protons along the chain of hydrogen bonds between water molecules catalyses the reaction, accelerating the formation of formaldehyde. Calculating the energetic landscape of the two mechanisms we find that while internal isomerization (mechanism 1) requires an over-the-barrier reaction, the water-assisted pathway (mechanism 2) can run smoothly downhill, a so-called barrierless reaction.

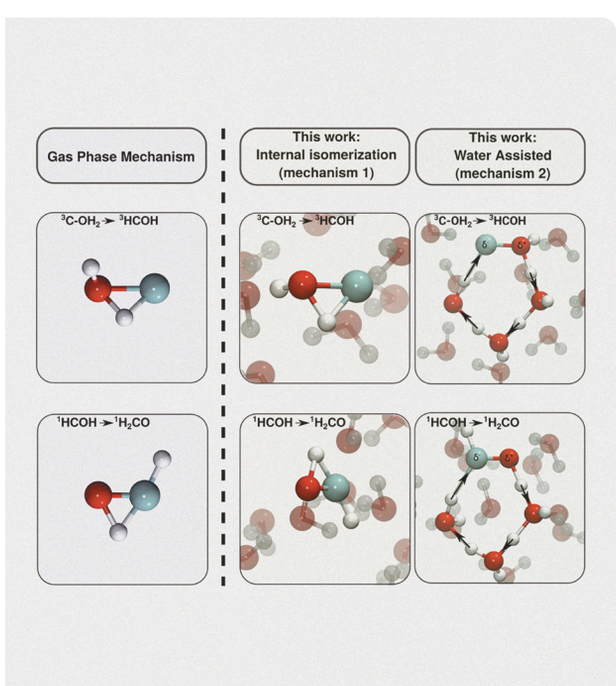


Figure 2: Reaction mechanisms for the reaction of the carbon atom with a water molecule, in the gas phase, on top of a water ice surface and embedded in the ice surface.

Reaction mechanism explained in simple terms

The closest analogy of this mechanism from our everyday life is the translation of switches on railway tracks. The rails remain in place, but the logistics of the connections changes in a simultaneous fashion. Such transformations are easy and do not require a lot of energy, which explains why formaldehyde is expected to be formed, despite the difficulty of the reaction taking place in absence of water.

Linking to experimental work

Experiments at the Laboratory for Astrophysics confirm the ease with which H_2CO is formed when a H_2O ice is 'irradiated' with C-atoms. The infrared spectra for a number of experiments are depicted in Figure 3. Particularly striking is that the reaction with heavy water, D_2O, leads to a nearly equal amount of D_2CO, compared to H_2CO. This signifies that the reaction that takes place is not influenced by changing the water isotope, which is a trick in physical chemistry to confirm that, indeed, no barrier is present for the reaction pathway.

The evidence of a catalytic effect of water – and potentially other hydrogen bonded networks – suggests that proton-transfer reactions may operate in interstellar ices in the presence of adsorbates that polarise their surroundings. Specifically, the formation of H_2CO in early stages of a molecular cloud lifetime points to an early formation of carbon-bearing (complex) organic molecules. In the near future, the presence of formaldehyde in water-rich ices will hopefully be probed by the James Webb Space Telescope.

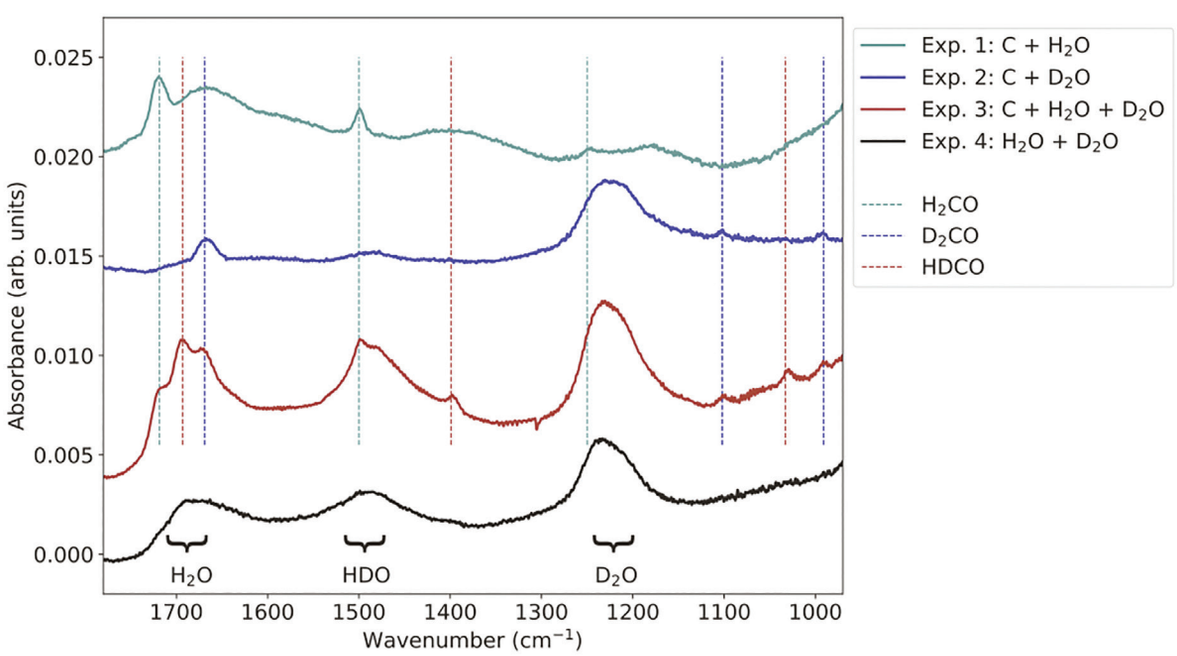


Figure 3: Reflection Absorption InfraRed spectra of four experiments that indicate that all three formaldehyde isotopes can be formed with ease on different isotope-substituted water ices.

Mocking the Universe: A realistic comparison between simulations and observations

Anna de Graaff

Over the past decade large simulations of galaxy formation and evolution have produced increasingly realistic model universes. Through comparison with observations, these models not only provide an assessment of our current understanding of our own Universe, but also offer new insights into the physical processes underlying our observations. However, there are fundamental differences between simulations and observations and the ways in which they are analysed, which are often overlooked: how do these differences affect the physical inferences made from the simulations?

Galaxy formation is a highly intricate process, which starts with the initial collapse of dark matter haloes, is followed by the formation of stars and black holes, and is further complicated by the feedback processes associated with the evolution of these same stars and black holes. Cosmological simulations aim to model several thousand galaxies simultaneously, and therefore need to incorporate all these physical processes. However, because of the sheer scale of these simulations, individual stars cannot be tracked: rather, the resolution is limited to building blocks that contain a mass of about 10^6 Solar masses.

Theorists therefore approximate the physical processes that take place below the resolution limit with simplified prescriptions. This involves a large number of free parameters and degeneracies, which are constrained by comparison with observations: this procedure is also referred to as "tuning"'. Typically, the key observable used for this tuning is the galaxy stellar mass function in the local Universe, which describes the number density of galaxies as a function of their stellar masses.

Other observables that provide crucial measures of success are related to the structures of galaxies, i.e., the sizes and morphologies of galaxies, and the corresponding relations between galaxy size and stellar mass. Recent simulations have been shown to successfully reproduce a broad distribution of galaxy types, ranging from disc-like galaxies with prominent spiral arms to passive spheroids. The sizes of these disc galaxies have also been found to be in close accord with observations in the local Universe, in contrast with the simulated quiescent spheroids that are significantly larger than observed.

However, these conclusions are based on direct comparisons between simulations and observations: the 3D stellar mass density profiles of simulated galaxies are compared with the 2D surface brightness profiles measured from optical imaging. Not only do the measurement techniques differ significantly, but also the physical quantities that are measured. Due to these systematic uncertainties, the question of how realistic simulations truly are still remains unclear.

Creating mock observations of simulated galaxies

Considerable progress has been made by the post-processing of simulations to model the light emitted by the simulated stellar mass. Trayford et al. (2017) modelled the optical emission from galaxies in the EAGLE simulations, by assigning each building block of stars a spectrum based on its properties (e.g., age and metallicity). All these spectra were then projected to form high-resolution 2D images of galaxies, while taking into account the scattering and absorption of light due to dust by employing a radiative transfer code. These images are still noise-free, however, and do not include other observational effects, such as the sky background

or point spread function (PSF) of the instrument and seeing.

In de Graaff et al. (2022), we set out to use these optical images as a basis to (i) quantify observational and measurement biases and (ii) assess the realism of the EAGLE simulations. Simulated galaxies were placed at a redshift z=0.1 to create two sets of images (see Figure 1): the first contains the projected stellar mass distributions, which were convolved with a realistic PSF and we subsequently applied background, detector and shot noise. The second set relies on the optical images from Trayford et al. (2017), which we also treated with a realistic PSF smoothing and noise model, to create mock images that resemble data from the Sloan Digital Sky Survey (SDSS).

Next, we measured the structural properties of the galaxies from these images, by following the exact same methods that are conventionally used in observational studies. We performed an automated source detection within each image, and modelled the projected density profiles of the detected galaxies with parametric models. These models, parameterised by Sersic profiles, fit the shape, size, total stellar mass or luminosity, as well as the steepness of the density profiles.

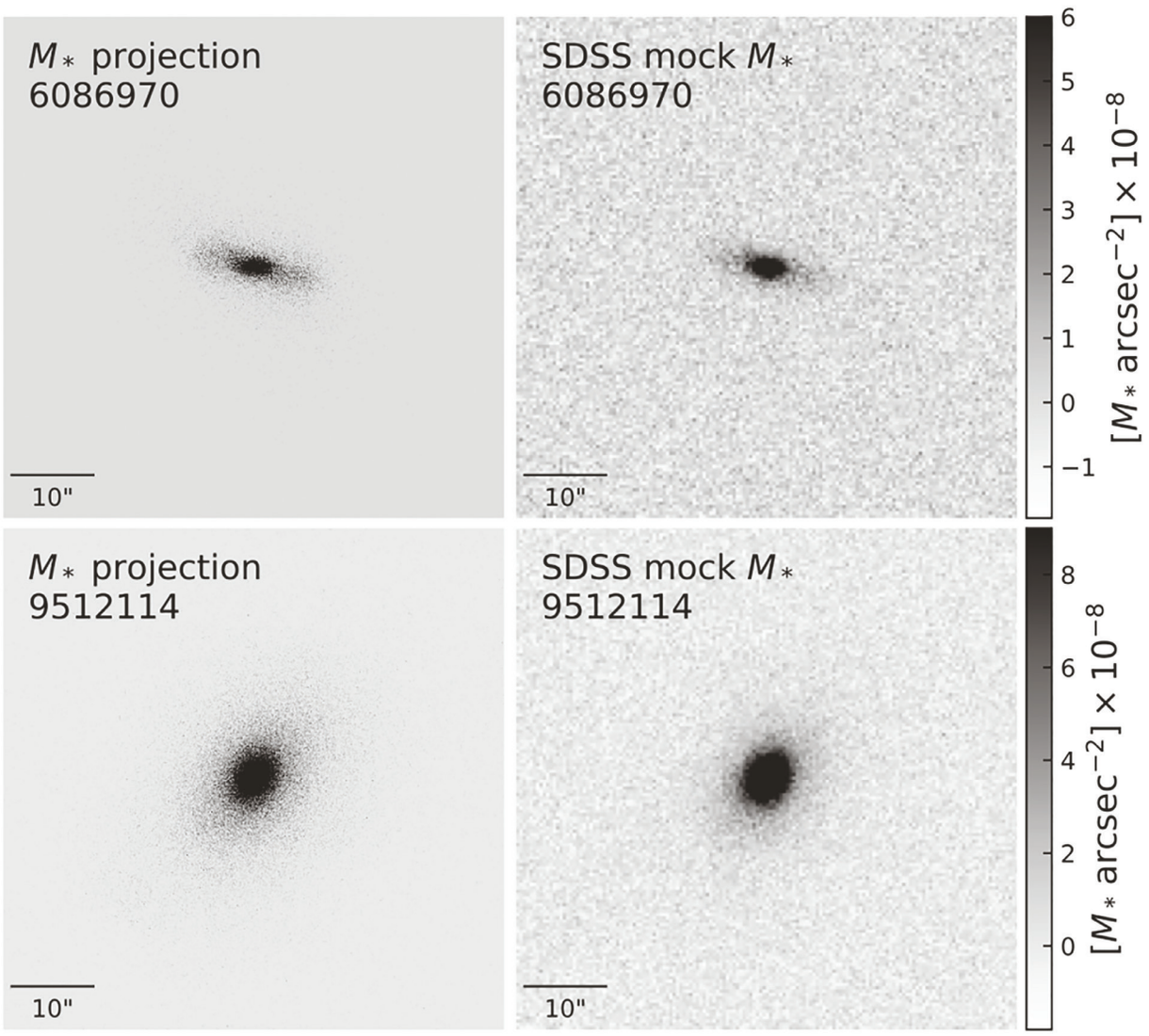


Figure 1: Mock images constructed from the stellar mass distributions of galaxies in the EAGLE simulations (left) and their forward-modelled optical light distributions (right). Young stellar populations are very luminous despite comprising only a small fraction of the total galaxy mass, which can lead to strong, visible differences between the two sets of images.

The importance of apples to apples comparisons

Our main focus was on the sizes of galaxies, as the relation between galaxy size and stellar mass is often used as a critical test of the fidelity of a simulation, and also used in the tuning process. Armed with the two sets of measurements of the galaxy structural properties, we were able to evaluate the effects of different measurement techniques and the different physical quantities probed (i.e., stellar mass versus optical light).

The "theorist's view"[1] of the stellar mass-size relation uses measurements taken directly from the EAGLE 100 Mpc^3 simulation (Figure 2, left panel). Star-forming (blue) and quiescent (red) galaxies both become larger with increasing stellar mass, albeit at different rates. The star-forming relation matches nearly perfectly with observational results based on SDSS imaging (Lange et al. 2015), whereas the quiescent galaxies are too large by about 60%.

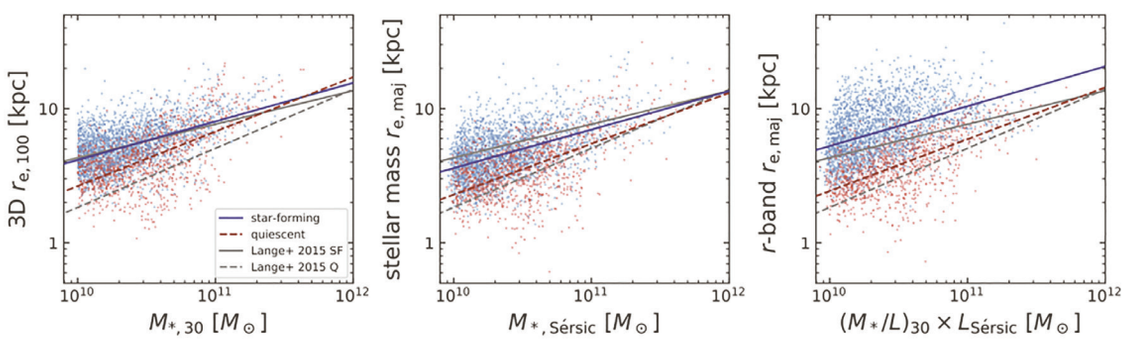


Figure 2: Observational biases have a significant effect on the inferred stellar mass-size relation: the conventional size and mass measurements from simulations (left) differ systematically from observational measurement methods (middle), which is further enhanced by the difference in measuring stellar mass versus optical light (right).

With our measurements from the stellar mass images, we looked at the impact of using measurement methods that are consistent with observations (Figure 2, middle panel). Neither star-forming nor quiescent galaxies now match with the observed scaling relations, and there is a clear systematic offset between the different measurement methods. The perfect agreement that was found previously for the star-forming galaxies is therefore in some sense just coincidence!

Finally, we used the measurements from the mock optical images to make a fair comparison (Figure 3, right panel). The difference is striking: for individual galaxies, the optical size can be up to three times larger than the stellar mass size. The resulting mass-size relation is shifted, with simulated galaxies being larger than observed at all masses (by 25%). Interestingly, the separation between the star-forming and quiescent populations matches very well with observations, as does the increased scatter.

Despite a slight offset, the simulated galaxies follow the observed mass-size relation remarkably closely.

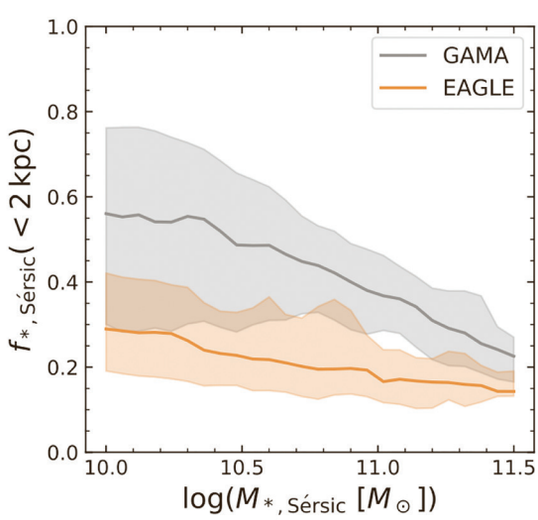


Figure 3: Fraction of stellar mass enclosed within an aperture of 2 kiloparsecs as a function of the galaxy stellar mass. Although the sizes agree well between the EAGLE simulations and local observations (Figure 2), the density profiles diverge significantly, as the simulations contain too few bulge-like galaxies with high central densities.

However, if we zoom in on the exact density profiles of these galaxies, strong differences begin to appear. The light profiles of the simulated galaxies are significantly less centrally concentrated than observed (see Figure 3). Strikingly, we have found that bulge-like galaxies appear to be missing almost entirely from the simulations, whereas these make up a large fraction of (massive) galaxies in the real Universe.

This apples-to-apples comparison has provided a very different view of simulated galaxies: in some ways the simulations perform better than previously thought (i.e., the sizes), yet, in other aspects they are significantly less realistic than earlier work had indicated.

As observations become ever more precise, stronger constraints are also placed on the theoretical models. For an accurate tuning and fair evaluation of these simulations, it will therefore be critical to take systematic observational and measurement biases into account. In turn, the simulated universes can then offer a much needed aid in the interpretation of our observations.

An inherited complex organic reservoir in a warm planet-hosting disk

Alice S. Booth

Planets form in the disks of gas, dust and ice around young stars. The composition of the disk material will determine the composition of the forming planets and importantly, set the potential for planets to produce and support habitable environments. Assessing the potential habitability of forming planetary systems is a challenge though. One way to do this is by measuring the inventory of complex organic material available during planet formation. Complex organic molecules (COMs) are molecules with five or more atoms composed of hydrogen and carbon with oxygen and/or nitrogen. COMs bridge the gap in complexity between the two and three atom molecules that are typically found in space, with the bio-molecules that are needed for life, such as amino acids, sugars and proteins.

A COM of particular significance is methanol (CH_3OH). This COM is only formed efficiently on the surfaces of very cold dust grains (<20K) via the hydrogenation of CO ice. Therefore CH_3OH forms very efficiently in the cold, dark, molecular clouds – the formation site of stars. Laboratory experiments have revealed CH_3OH as a feedstock for building molecules of higher complexity, including simple esters, ketones, and aldehydes. Therefore, the detection CH_3OH is an indication that more complex molecules are also likely present. During the process of star formation these ices can sublimate (T>100K) leading to the ability to detect gas phase COMs at millimetre wavelengths. COMs have now been found to be ubiquitous in the warm envelopes surrounding forming stars. However, it is still uncertain if at least some of this icy organic reservoir survives the assembly of the protoplanetary disk and most importantly if it is able to be incorporated into forming planets, moons and comets.

Protoplanetary disks are much cooler than protostellar envelopes therefore the COMs remain frozen onto dust grains for the bulk of the disk. Recently, observations of disks with the ALMA have resulted in the first detections of simple members of some key functional groups in organic chemistry: acetonitrile (CH_3CN, a simple nitrile), methanol (CH_3OH, an alcohol), and formic acid (HCOOH, a carboxylic acid). These results show that relatively complex molecules are present at the epoch of planet formation, but can not yet provide firm constraints on their origin: in situ formation versus inheritance from the cold cloud phase. For example, TW Hya is a very cold disk where CO is frozen-out in much of the disk therefore facilitating the local formation of CH_3OH, i.e., there is no need to invoke inheritance.

The temperature structures of protoplanetary disks strongly depend on the luminosity of the host star. Thus, disks around intermediate mass Herbig Ae/Be stars will have a substantially lower fraction of disk mass at the coldest temperatures (<20K) than their cooler Sun-like (T-Tauri) counterparts like TW Hya. This means that disks around Herbig Ae/Be stars are expected to be poor in CH_3OH and as a result poor in the other COMs important for the formation of prebiotic molecules. This proposition was supported by the non-detection of CH_3OH with deep ALMA observations towards the otherwise molecule-rich Herbig Ae/Be disks around HD163296 and MWC480 as well as detailed astrochemical models that predict a negligible reservoir of CO ice in these systems.

In 2021 we reported the first detection of the key COM CH_3OH in a Herbig Ae/Be disk. Using ALMA Band 7 observations we detected multiple transitions of CH_3OH in the HD100546 disk. The HD100546 system has been well studied over a range of wavelengths and the disk has been found to be warm and gas rich. There is also compelling evidence for two giant planets embedded in the disk at ~10 and ~60 au. Our new data uncover a previously unknown reservoir of circumstellar complex organic molecules and show that disks around Herbig Ae/Be stars are at least as chemically complex as their Sun-like counterparts. The emission is compact within the spatial resolution of our observations. The emission map of CH_3OH compared to the dust disk is shown in Figure 1.

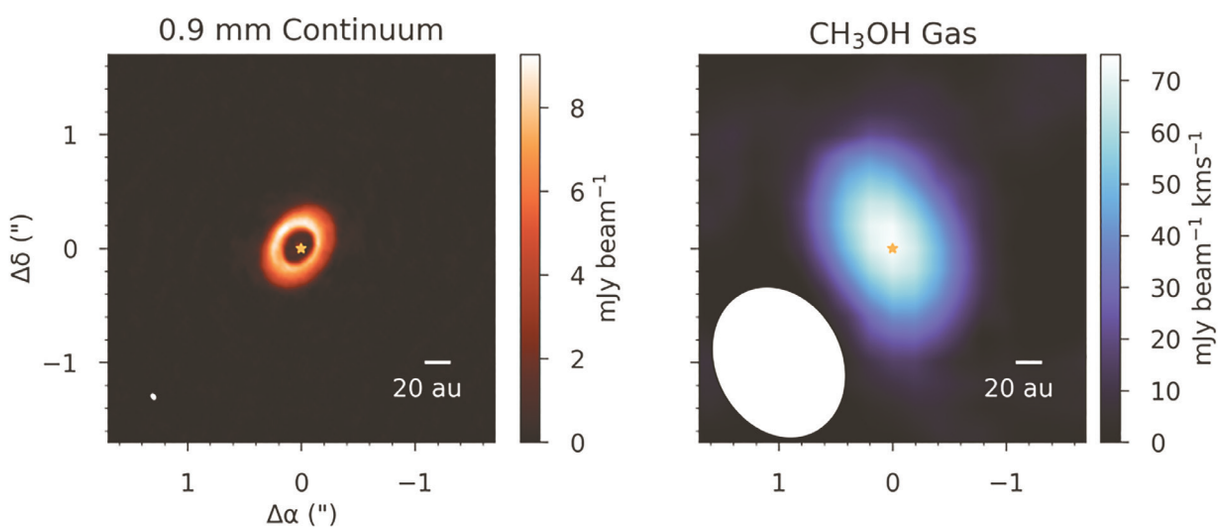


Figure 1: Integrated intensity maps of dust and line emission from the HD 100546 disk. Left – 0.9 mm dust continuum emission from Pineda et al. 2018 showing a clear ring with an inner cavity. Right – CH_3OH emission which is compact / unresolved but originating from the inner 50 au of the disk. The spatial resolution, beam size, of each set of observations is shown by an ellipse in the bottom left corner of each image. The orange star shows the location of HD 100546.

The bulk of the CH_3OH emission in the HD100546 disk originates from the warmer inner disk (< 50 au). Hence it is likely a thermally desorbed reservoir of CH_3OH originating from the edge of the dust cavity that is exposed to radiation from the central star. Figure 2 presents the spectrum of the CH_3OH J=51,5,1-41,4.1 transition at 290.249GHz with an upper energy level of 70K. This is a much warmer line than those detected in TW Hya. Direct evidence for the high (>100K) dust temperature at the cavity edge, and thus the conditions for ice sublimation, in the HD100546 disk comes from the complementary detection of crystalline silicates. We used models to investigate the chemical origin of the CH_3OH in the HD100546 disk and show that CH_3OH cannot be formed locally anywhere in the disk. This is strong evidence that at least some of the organic material survives the disk formation process and is available then be incorporated into forming planets, moons and comets. It also implies that crucial prebiotic chemical evolution already takes place in dark molecular clouds before the formation of stars.

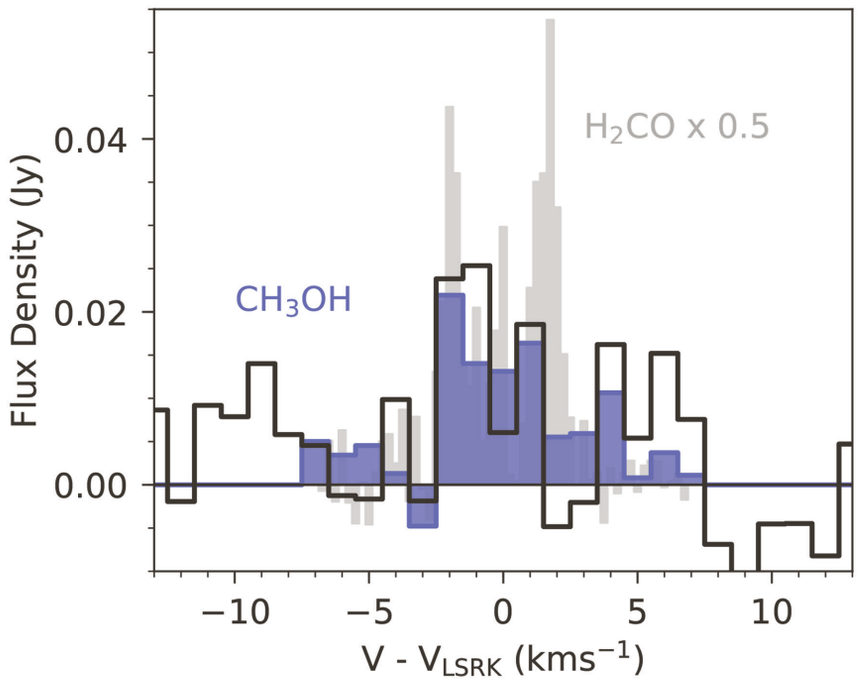


Figure 2: The CH_3OH J=51,5,1-41,4.1 spectra extruded from a Keplerian mask (blue) and elliptical mask (black). Also for reference a H_2CO line (grey) is shown to which velocities disk emission is expected – this is consistent with the CH_3OH line.

More recently we have also detected CH_3OH in the warm Herbig disk IRS48 further strengthening our hypothesis (van der Marel, Booth, et al. A&A 651, L5, 2021). To expand this work we have an ALMA Cycle 8 program to target other COMs in both of these disks.

The detection of these complex molecules will allow us to make clearer connections to the COMs detected in comets in our own solar system and allow us to begin to assess their availability across the galaxy.

You can read about this result further in –
Booth et al. (2021) Nature Astronomy,
volume 5, pages 684–690
https://www.nature.com/articles/s41550-021-01352-w

Dario Gonzalez Picos

Dario Gonzalez Picos

Floor der Kink

Aleksandar Shulevski

Dario Gonzalez Picos

PhD Defences

NAME	DATE	SUPERVISORS	THESIS TITLE
L.A. Boogaard	2021-02-25	Prof.dr. P.P. van der Werf / Dr. R.J. Bouwens	*Cold gas in distant galaxies*
L. Tychoniec	2021-03-09	Prof.dr. E. F. van Dishoeck	*Protostellar jets and planet-forming disks: Witnessing the formation of Solar System analogues with interferometry*
C.H.M. Pabst	2021-03-18	Prof.dr. A.G.G.M. Tielens	*Orion's Dragon and Other Stories*
F.A. Concha Ramirez	2021-04-06	Prof.dr. S.F. Portegies Zwart / Prof.dr. M. Hogerheijde	*Simulating the birth environment of circumstellar discs*
K.L. Emig	2021-04-29	Prof.dr. A.G.G.M. Tielens / Prof.dr. H.J.A. Röttgering	*From Star-formation to Recombination: Expanding our View of the Radio-Recombination-Line Universe*
P. Dabhade	2021-05-25	Prof.dr. H.J.A. Röttgering	*Unveiling the nature of giant radio galaxies*
D.S. Doelman	2021-06-22	Dr.ir. F. Snik	*It's just a phase: High-contrast imaging with patterned liquid-crystal phase plates to facilitate characterization of exoplanets*
G. Di Gennaro	2021-07-08	Dr. R.J. van Weeren	*Merging galaxy clusters: probing magnetism and particle acceleration over cosmic time*
D. Campisi	2021-09-14	Prof.dr. A. G. G. M. Tielens / Dr. A.L.M. Lamberts	*Interstellar Catalysts and the PAH universe*
A.J. Bohn	2021-09-22	Dr. M.A. Kenworthy / Dr. F. Snik	*Young suns and infant planets: Probing the origins of solar systems*
S.P. Bos	2021-09-30	Dr.ir. F. Snik	*Focal-plane wavefront sensors for direct exoplanet imaging: Theory, simulations and on-sky demonstrations*
R.E. van den Berg	2021-10-06	Prof.dr. F.H. van Lunteren / Prof.dr. D. van Delft	*Van 't Hoff. Een gedreven buitenstaander*
R.G. van Holstein	2021-10-13	Prof.dr. C.U. Keller / Dr.ir. F. Snik	*High-contrast imaging polarimetry of exoplanets and circumstellar disks*
H.S.B. Algera	2021-10-27	Dr. J.A. Hodge	*Distant Star Formation in the Faint Radio Sky*
M.C. Fortuna	2021-11-25	Prof.dr. H. Hoekstra	*Galaxy alignments from multiple angles*
T. Terwisscha van Scheltinga	2021-11-30	Prof.dr. H.V.J. Linnartz / Prof.dr. M. Hogerheijde	*Ice and Gas in Protostellar Clouds and Planet-forming Disks*
D.M. Smit	2021-12-08	Prof.dr. K.H. Kuijken	*Light Weighed: On the Statistics and Systematics of Weak Gravitational Lensing*
M. Bulak	2021-12-09	Prof.dr. H. V. J. Linnartz / Dr. R.J. Bouwens	*UV Photodesorption and Photoconversion of Interstellar Ices*

Publication overview

The Observatory continued to produce scientific papers throughout the year despite the impact of Corona. The number of publications increased from 640 in 2020 to 690 in 2021 – of these, 237 were in Astronomy and Astrophysics, 145 in MNRAS, 127 in AAS journals (AJ, ApJ, Supplements and Letters) and 19 in Nature and Science journals.

Colloquia and Lectures

Scientific Colloquia

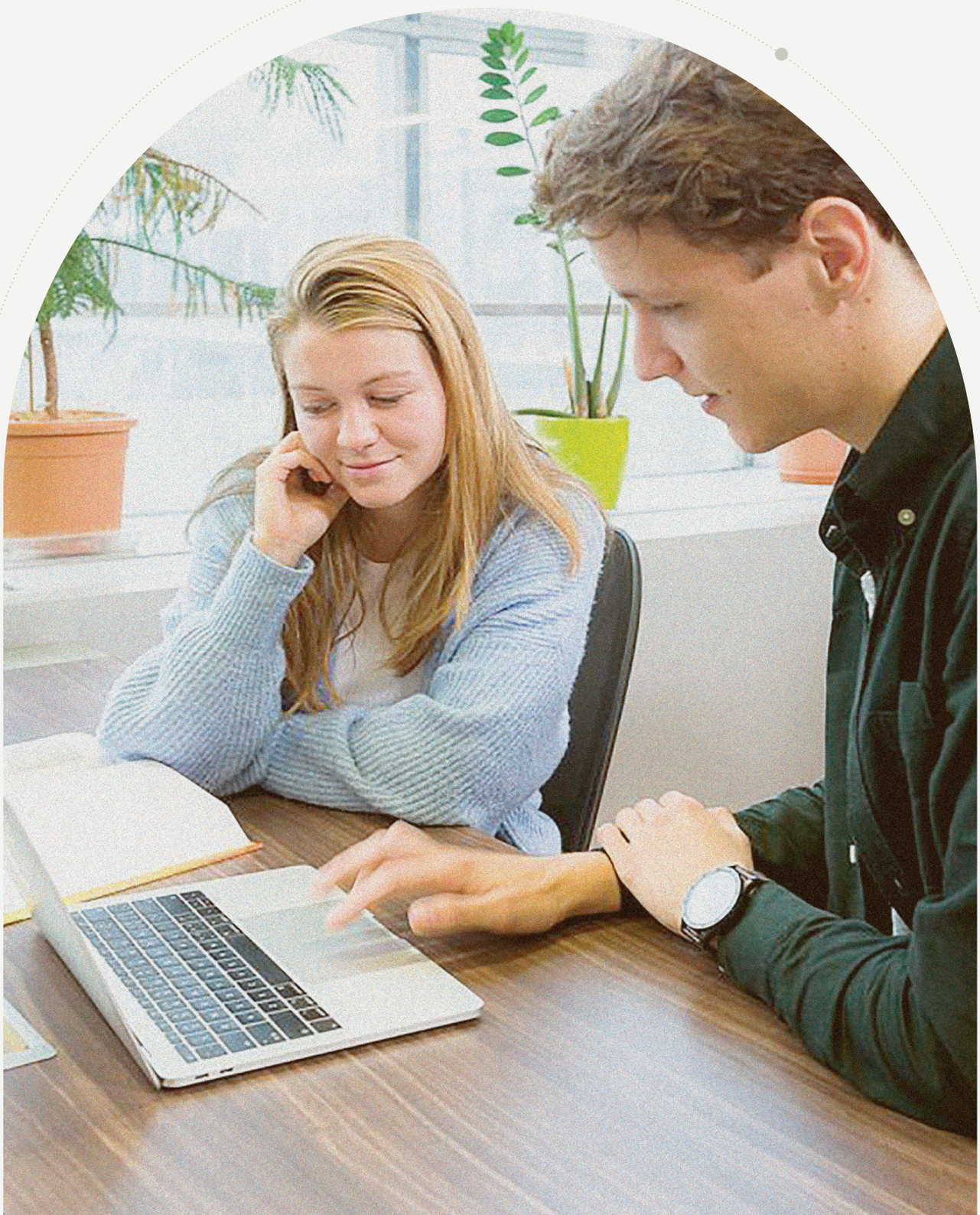
2021-02-02	**Rocio Kiman**	City University of New York	*Age-relations for low-mass stars*
2021-02-04	**Shu-ichiro Inutsuka**	Nagoya University	*Bubble-Filament Paradigm of Star Formation*
2021-02-11	**Robert Brakenridge**	Institute for arctic and alpine research	*Solar system exposure to supernova gamma-ray radiation*
2021-02-18	**Jan Eldridge**	University of Auckland	*Some of the things binary stars do....*
2021-02-24	**Fernando Rico-Villas**	Centro de astrobiología (CSIC-INTA)	*Witnessing the Early Stages of Super Star Clusters*
2021-03-04	**Keith Hawkins**	The University of Texas at Austin	*Galactic Archaeology with Gaia and Large Spectroscopic Surveys*
2021-03-11	**Amirhossein Bagheri**	ETH Zurich	*Dynamical evidence for Phobos and Deimos as remnants of a disrupted common progenitor*
2021-03-18	**Reinhard Genzel**	MPG	*A Forty-Year Journey*
2021-03-25	**Martin Hardcastle**	University of Hertfordshire	*The environmental effects of the radio-loud AGN population*
2021-04-08	**Katie Auchettl**	Melbourne University	*The imprint of their explosions: Using supernova remnants to understand stellar death*
2021-04-15	**Sohrab Rahvar**	Sharif University	*The astrophysical applications of gravitational microlensing and future prospects*
2021-06-03	**Mirjana Povic**	Ethiopian Space Science and Technology Institute	*Developments in Ethiopia and Africa through astronomy research and education*
2021-06-10	**Duilia de Mello**	Catholic University of America and NASA Goddard	*Deep Images of Mergers (A citizen Science Project)*
2021-06-17	**Sara Ellison**	University of Victoria	*Gas and star formation in the nearby universe with the ALMA-MaNGA QUEnching and STar formation (ALMaQUEST) survey*
2021-06-24	**Helgi Rafn Hrodmarsson**	Leiden Observatory	*Mental health in academia – A crisis*
2021-07-08	**Harry Cliff**	University of Cambridge	*Rare beauty – are we seeing signs of new physics at the LHCb experiment?*

2021-07-15	**Arman Shafieloo**	Korea Astronomy and Space Science Institute	*Status of the Concordance Model of Cosmology*
2021-07-16	**Lachlan Lancaster**	Princeton University	*A Fractal Model for Turbulent Stellar Wind Bubbles*
2021-09-02	**Jason Hessels**	UvA (University of Amsterdam)/ASTRON	*Pinpointing fast radio bursts in space and time*
2021-09-09	**Silvia Toonen**	UvA (University of Amsterdam)	*Stellar interactions & transients*
2021-09-20	**Edwin Bergin**	University of Michigan	*diversity and excellence hiring practices*
2021-09-23	**Sergei Klioner**	Lohrmann Observatory, TU Dresden	*The acceleration of the Solar System from Gaia astrometry*
2021-09-30	**Priyamvada Natarajan**	Yale University	*Disentangling nature and nurture: tracing the origin of seed black holes*
2021-10-07	**Elisabeth Tasker**	JAXA	*JAXA's Hayabusa2 mission: the search for the start of habitability*
2021-10-14	**Celine Peroux**	ESO	*The Comic Baryon and Metal Cycles*
2021-10-19	**Lisa Dang**	McGill	*Characterizing Evolving Exoplanets and their Atmosphere with the Spitzer Space Telescope and Beyond*
2021-10-21	**Natasha Hurley-Walker**	ICRAR	*An ultra-long period magnetar with periodic radio emission*
2021-10-26	**Christopher Agostino**	Indiana University	*Physical Drivers of Emission Line Diversity of SDSS Seyfert 2s and LINERs After Removal of Contributions by Star Formation*
2021-11-02	**Stefan Schuldt**	Max Planck institute for Astrophysics	*Strong lens modeling through deep learning for LSST*
2021-11-04	**Harish Vedantham**	Kapteyn institute/ ASTRON	*Radio flashes from plasma storms around exoplanets*
2021-11-09	**Dhruba Dutta Chowdhury**	Department of Astronomy, Yale University	*Constraining Dark Matter through Gravitational Heating and Cooling Processes*
2021-11-18	**Steven Balbus**	Oxford University	*Time-dependent Kerr discs and tidal disruption events*
2021-11-23	**Vicky Fawcett**	Durham University	*How are red and blue quasars different?*
2021-12-02	**Abel Mendez**	University of Puerto Rico	*Modeling Planetary Habitability*
2021-12-09	**Anthony Mezzacappa**	Joined Institute for Computational Science	*Core Collapse Supernova Modeling: Assessing Progress, Future Challenges*
2021-12-16	**Floris van der Tak**	RUG (Rijksuniversiteit Groningen)	*The carbon footprint of astronomy research in the Netherlands*

PhD Colloquia

2021-02-09	**Francisca Concha-Ramirez**	*Simulating the birth environment of circumstellar discs*
2021-02-23	**Leindert Boogaard**	*Cold gas in distant galaxies*
2021-03-02	**Cornelia Pabst**	*Orion's Dragon and Other Stories*
2021-03-08	**Lukasz Tychoniec**	*Protostellar jets and planet-forming disks: Witnessing the formation of Solar System analogues with interferometry*
2021-06-01	**Steven Bos**	*Focal-plane wavefront sensors for direct exoplanet imaging*
2021-06-15	**David Doelman**	*It's just a phase: high-contrast imaging with patterned liquid-crystal phase plates to facilitate characterization of exoplanets*
2021-07-06	**Alexander Bohn**	*Young suns and infant planets: Probing the origins of solar systems*
2021-09-07	**Dario Campisi**	*Interstellar Catalysts and the PAH Universe*
2021-09-14	**Rob van Holstein**	*High-contrast imaging polarimetry of exoplanets and circumstellar disks*
2021-09-21	**Maria Cristina Fortuna**	*Galaxy Alignments from Multiple Angles*
2021-10-19	**Hiddo Algera**	*Distant Star Formation in the Faint Radio Sky*
2021-11-02	**Omar Contigiani**	*Exploring the edge*
2021-11-16	**Jeroen Terwisscha van Scheltinga**	*Ice and Gas in Protostellar Clouds and Planet-forming Disks – A Combined Laboratory and Observational Study*
2021-11-30	**Michal Bulak**	*UV Photodesorption and Photoconversion of Interstellar Ices – the laboratory perspective*
2021-12-07	**Merijn Smit**	*Light Weighed: On the Statistics and Systematics of Weak Gravitational Lensing*
2021-12-14	**Andrew Barr**	*The infrared Spectrum of Massive Protostars: Circumstellar Disks and High Mass Star Formation*

Education



Credit: Pim Rusch

Bachelor and Master in Astronomy

The teaching and training of students is a major priority of Leiden Observatory, which offers both a university bachelor (BSc) and master (MSc) programme in astronomy. The BSc programme is 3 years and is partly taught in Dutch, with combinations of lectures, problem classes, and practicals. In addition to astronomy courses, the programme consists in the first year of a significant fraction of courses in mathematics, physics, and informatics. First year students conduct their first astronomical observations with the modern LUF/Gratama telescope on the roof of the historic Observatory building in the centre of Leiden, and learn about coordinate systems during a lecture at the planetarium in Artis, Amsterdam. In years two and three the emphasis is increasingly on astronomy. Highlights include observations at the 2.4m Isaac Newton Telescope on La Palma (Canary Islands) carried out and analysed by the students, and the 6-months research project at the end of their BSc.

The MSc programme lasts for two years and is fully taught in English, attracting many foreign students.The Observatory has a strong international flavour, with close ties to other astronomy institutes in Europe and the U.S. Many students, postdocs and staff come from abroad, and the institute hosts regular visitors from all over the world. Education and research focus on three major themes: (i) the formation and evolution of galaxies, (ii) the birth of stars and planets, and (iii) cutting-edge instrumentation. The astrochemistry laboratory, optics laboratory and high performance computing facilities additionally function as training grounds for students, and are used for student research projects. Students graduate with a broad knowledge of astronomy and astrophysics, but may specialise in various subfields.

In 2021, the MSc programme in Astronomy offered seven specialisations:

1. Astronomy Research
2. Astronomy and Cosmology
3. Astronomy and Instrumentation
4. Astronomy and Data Science
5. Astronomy and Education
6. Astronomy and Business Studies
7. Astronomy and Science Communication and Society

Student Numbers

Student numbers have been continuously rising for several years and in 2021, 116 freshmen started in our bachelor astronomy programme. Of this number, 37 (32%) were women, and 41 (35%) pursued a combined astronomy/physics or astronomy/mathematics degree. The Observatory registered a total number of 269 BSc students at the end of the year, of which 103 aimed at a combined astronomy/physics degree or astronomy/mathematics degree; 35% of all BSc students are female. Due to the continuing Covid-19 pandemic and changes in the waiver policy, in 2021, the inflow of master students has dropped to 35 students. In total there were 129 MSc students, including 56 women, 1 non-binary, and 51 of foreign nationality.

Credit: Pim Rusch

Organisation

The entire teaching program is organised and supported by the Education Office Astronomy (EOA), which deals with all aspects of the curriculum, including organisation, student support, outreach and internationalisation. The EOA team currently consists of a Director of Education, Head of Education Office Astronomy & Programme Coordinator, Study Advisor, PR Education Coordinator, Student Affairs Officer Bachelor, Student Affairs Officer Master and a Support Officer.

In addition to counselling by the student adviser, incoming bachelor students were assigned to small groups meeting at regular intervals with a staff mentor and a senior student mentor. In the tutor programme, physics and astronomy freshman students were provided on a voluntary but regular basis with coaching by senior students. In the master programme the buddy system has been continued. In both programmes students write a Study Plan, which must be approved by the Study Advisor. The astronomy curriculum is monitored by the 'Programme committee' (Opleidingscommissie), which advises the Director of Education on all relevant matters, and which was chaired by Hogerheijde. Under the authority of the Education Committee, the lecture course monitoring system was continued. In this system, students provide feedback to lecturers during and after the course.

Quality control of all aspects of the exams is the responsibility of the Board of Examiners (Examencommissie) chaired by Hogerheijde. Admission to the master-curriculum for students without a BSc in astronomy from a Netherlands university requires a recommendation by the 'Admissions committee' (Toelatingscommissie) chaired by Schrier.

Academic courses and pre-university programmes

BACHELOR COURSES — ACADEMIC YEAR 2020/2021

Inleiding astrofysica	**Hoekstra**
Planetenstelsels	**Brown**
Praktische sterrenkunde	**Monreal Ibero**
Modern Astronomical Research	**Russo**
Stars	**Snellen**
Galaxies and Cosmology	**Hodge**
Astronomy Lab and Observing Project	**Van Weeren**
Radiative Processes	**Hogerheijde**
Astronomical Observing Techniques	**Röttgering**
Astrobiology	**Fridlund**
Astronomical Relativity	**Rossi**
Research Skills and Scientific Integrity	**Linnartz**
Bsc Research Project	**Linnartz**
Statistics and Data Analysis	**Van Velzen**
Statistics AN	**Cautun/Nagler**
Keerpunten in de geschiedenis van de natuurwetenschappen	**Van Lunteren**
On Being a Scientist (facultair)	**Van Lunteren**

MASTER COURSES — ACADEMIC YEAR 2020/2021

Stellar structure and evolution	**Viti**
Large scale structure and galaxy formation	**Kuijken**
Origin and evolution of the universe	**Schaye**
Interstellar medium	**van der Werf**
Star and Planet Formation	**McClure**
Simulation and Modeling in Astrophysics (AMUSE)	**Portegies Zwart**
Galaxies: structure, dynamics, and evolution	**Franx**
Astronomical telescopes and instruments	**Keller/Kenworthy**
Detection of light	**Brandl**
Science and the public: contemporary and historical perspectives	**Van Lunteren**
Observational cosmology	**Bouwens**
High-energy Astrophysics	**Kaastra**
High contrast imaging	**Kenworthy**
Project management for scientists	**Keller**
Modern Astrostatistics	**Sellentin**
Exo-planets: Interiors and Atmospheres	**Miguel**
Gravitational Lensing	**Kuijken/Hoekstra**
Numerical Recipes in Astrophysics	**Van Daalen**

Degrees awarded in 2020/2021

A total of 45 students obtained their Bachelor's Degree.

NAME	DATE	PRESENT POSITION
Quincy Bosschaart	2021-06-30	MSc Astronomy Research
Wessel van Dam	2021-06-30	MSc Computer Science
Timon van Dieren	2021-06-30	MSc Physics
Esther van Dijk	2021-06-30	MSc Astronomy and Data Science
Maarten Elion	2021-06-30	MSc Physics
Fleur Evertsen	2021-06-30	MSc Aerospace Engineering (TU Delft)
Jasper Jansen	2021-06-30	MSc Astronomy Research
Evelyn van der Kamp	2021-06-30	MSc Astronomy and Cosmology
Liz van der Kamp	2021-06-30	MSc Astronomy and Cosmology
Riens Kievit	2021-06-30	MSc Astronomy and Data Science
Bowie van Neerbos	2021-06-30	MSc Astronomy and Cosmology
Bart Ouwehand	2021-06-30	MSc Astronomy of MSc Applied Physics (TU Eindhoven)
Levi Peeters	2021-06-30	Premaster for MSc Informatica
Merel Reitsma	2021-06-30	MSc Astronomy & Education
Benjamin Silk	2021-06-30	MSc Astronomy and Data Science
Lieke Sippens Groenewegen	2021-06-30	MSc Physics
Martje Slob	2021-06-30	MSc Astronomy Research

Lindsay Spoor	2021-06-30	MSc Physics
Nelleke Theijssen	2021-06-30	MSc Astronomy and Science Communication and Society (en jaar daarna Education)
Bas van Veen	2021-06-30	unknown
Thomas Boxman	2021-07-30	MSc Astronomy and Cosmology
Qin Crebas	2021-07-30	MSc Sustainable Energy Technology (TU Delft)
Tessa van der Ent	2021-07-30	MSc Physics
Stef Heijnen	2021-07-30	MSc Astronomy and Business Studies
Owen Huisman	2021-07-30	MSc Applied Physics (TU Delft)
Pascal de Jong	2021-07-30	Master abroad
Hidde Kanger	2021-07-30	MSc Physics
Jessie de Kruijf	2021-07-30	MSc Astrophysics and Cosmology (Padua)
Kees de Kuijper	2021-07-30	MSc Space Science (Hong Kong)
Jaap Laging	2021-07-30	MSc Astronomy and Data Science
Lieuwe de Regt	2021-07-30	unknown
Rutger Rijnenberg	2021-07-30	Bestuursjaar LVVS Augustinus, as of MSc Astronomy & Data Science
Matthijs Romeijnders	2021-07-30	MSc Game and Media Technologies (Universiteit Utrecht)
Daniel Rutgers	2021-07-30	MSc Stochastics & Financial mathematics + MSc Econometrics (UvA)
Renze Suters	2021-07-30	MSc Applied Physics (TU Delft)
Izumi Takimoto Schmiegelow	2021-07-30	MSc Astrophysics and Cosmology (Padua)
Lucas Taling	2021-07-30	MSc Particle Physics (Imperial college/University of Edinburgh)
Gerardus Timmerman	2021-07-30	MSc Physics
Felix Vecchi	2021-07-30	MSc Physics (ETH Zurich)
Cyriel van Velzen	2021-07-30	MSc Mathematics & Physics (UvA)
Falco Verhoef	2021-07-30	MSc Physics
Amalia Villarrubia Aguilar	2021-07-30	MSc Cosmology and Astro-Particle Physics (Zurich)
Marieke Visscher	2021-07-30	MSc Physics
Kristie Wesdorp	2021-07-30	MSc Applied Physics (TU Delft) + premaster Econometrics and Management Science (Erasmus Universiteit)
Raul Wolters	2021-07-30	MSc Physics

Degrees awarded in 2020/2021

The following 32 students were awarded their Master's degree.

NAME	DATE	PRESENT POSITION
Chandramohan Vaishali	2021-01-29	PMO/Assistant Business Analyst
Danial Rangavar Langeroodi	2021-01-29	PhD at Niels Bohr Institute, Kopenhagen, Denmark
Ioannis Politopoulos	2021-01-29	Instrument Engineer at ASTRON, Groningen, Netherlands
Jacob Bieker	2021-01-29	Machine Learning Research Engineer at Open Climate Fix
Margherita Grespan	2021-01-29	PhD at National Centre for Nuclear Research, Warsaw, Poland
Okke van der Haak	2021-01-29	Data Analist at BAM Energy Systems
Zorry Belcheva	2021-01-29	PhD at Leiden Observatory
Alex Tripsas	2021-02-26	Optical Engineer at SA Photonics, Inc.
Lindsey Oberhelman	2021-02-26	PhD Student Researcher for Hydrangea/EAGLE simulation group
Auke Bruinsma	2021-03-31	IT-traineeship bij Yacht Trainees
Jolanda Frensch	2021-04-30	PhD at University of Geneva, Switserland
Luuk Oudshoorn	2021-05-30	Consultant in the financing of energy transition and infra projects at Rebel
Aniek van Ogtrop	2021-06-30	Data Scientist trainee at PostNL
Brent Maas	2021-06-30	Dotnet-developer at VWE Automotive, and PhD searching
Danker Roozemond	2021-06-30	BI & Analytics Engineer
Joost 't Hart	2021-06-30	Data Engineer/Data Scientist at Freeday.ai

Merel Donker	2021-06-30	Data Scientist at Belsimpel
Pengyu Liu	2021-06-30	PhD at University of Edinburgh, UK
Stefan van der Giessen	2021-06-30	PhD at University of Gent, Belgium
Yuan Chen	2021-06-30	PhD at Leiden Observatory
Aoife Taylor	2021-07-30	Project leader at Astronomy and Society group at Leiden Observatory
Bohan Yue	2021-07-30	PhD at University of Edinburgh, under a joint program with Leiden Observatory
Bryndís Ragnarsdóttir	2021-07-30	Specialist at Icelandic Medicines Agency – Lyfjastofnun Íslands
Callum Griffiths	2021-07-30	Intern for Astronomy and Society Group at Leiden University
Dazhi Zhou	2021-07-30	PhD at Cosmic Dawn Center, Kopenhagen, Denmark
Donald Serna-Grey	2021-07-30	Teaching introductory astronomy and physics in the US Pacific Northwest
Dylan Natoewal	2021-07-30	Middle and High school tutor
Gunnlaugur Stefánsson	2021-07-30	Data Analyst at CCP Games
Hritam Chakraborty	2021-07-30	PhD at University of Geneva, Switserland
Ivana van Leeuwen	2021-07-30	PhD at Leiden Observatory
Jeroen Jaspers	2021-07-30	Senior Associate Corporate Finance at ABN AMRO Bank
Joshiwa van Marrewijk	2021-07-30	PhD at Garching, ESO, Germany
Maryam Tajalli	2021-07-30	PhD in cosmology at the University of Victoria in British Columbia, Canada
Qing Zhou	2021-07-30	Algorithm engineer in a quantum tech company in Beijing
Siyu Wang	2021-07-30	Science communicator at Beijing Planetarium
Styliani Tsilia	2021-07-30	System Developer at DSW Zorgverzekeraar
Davide Angelini	2021-08-30	High school maths and physics teacher
Matthijs van Bree	2021-08-30	IT-consultant at Capgemini of Bartosz
Yunhao Zhang	2021-08-30	PhD at University of Edinburgh (joint programme Leiden)
Mariya Krasteva	2021-10-31	Young Graduate Trainee at ESTEC
Micha Heilman	2021-11-30	Junior Program Manager for Space Innovation programs and Space events at PLNT, Leiden, Netherlands
Elise Sanger	2021-11-31	Traveling and working, in the meantime finding a PhD position
Jelle Mes	2021-11-31	PhD at Leiden Observatory

Public Engagement with Astronomy

Astronomy & Society Projects 2021 Highlights

The aim of Leiden Observatory, and specifically of the Astronomy & Society Group, is to engage the public with the wonders of the Universe and share the scientific, technological, cultural and educational aspects of astronomy with society.

Oude Sterrewacht Leiden

The Old Observatory features exhibitions that connect astronomy & society. It is also an experimental space for new approaches to inform and engage the public with astronomy and science. In 2020, Leiden Observatory hosted the SKA's Shared-Sky Exhibition. The exhibit takes a cultural look at the starry sky by Aboriginal Australian and South African artists, and features colourful artwork that explores how these Indigenous cultures gave meaning to the appearance and position of familiar patterns in the sky.

www.oudesterrewacht.nl

Space Scoop

Space Scoop brings you the latest astronomy news from across the Universe in a language that's easy to understand. Each Space Scoop begins with a new discovery or image from space. Our partners write a press release that is then shared with us. Four SpaceScoop articles are published each month.

www.spacescoop.org

Citizen Science Lab

The Citizen Science Lab is an incubator and central hub for citizen science efforts at Leiden University. Through the H2020 project, EU.Citizen. Science the lab implemented a series of citizen-engaging activities with the community in Leiden and the Netherlands.

www.universiteitleiden.nl/en/citizensciencelab

Universe Awareness

The programme aimed to introduce children to the idea of global citizenship at a crucial stage of their development – to show them that they are part of an international community. Until the advent of UNAWE, there were no large-scale attempts to use astronomy as a tool for inspiring and educating young children. UNAWE was active in 63 countries and Leiden University Observatory was the founder and coordinator of the programme.

www.unawe.org

The International Day of Light

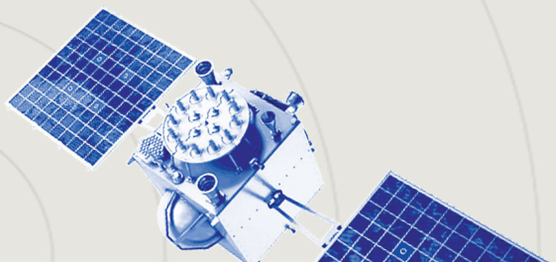
The International Day of Light is a global initiative that provides an annual focal point for the continued appreciation of light and the role it plays in science, culture and art, education, and sustainable development, and in fields as diverse as medicine, communications, and energy.

www.LightDay.org

SKIES – SKilled, Innovative and Entrepreneurial Scientists

The EU-funded SKIES project aims to provide for PhD and 1st-year postdoctoral researchers in the field of astronomy with a new set of skills integrating open science, innovation and entrepreneurship. With this, they will be gaining substantial experience equipping them for a career to fulfil their potential and contribute to society and the economy.

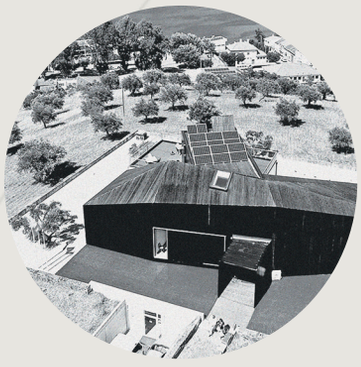
www.universiteitleiden.nl/en/news/2021/03/closing-the-skills-gap-for-young-researchers-through-innovation-and-entrepreneurship-training



IAU European Regional Office of Astronomy for Development

This office carries out and coordinates relevant astronomy-for-development activities in Europe, focusing on accomplishing the United Nations Sustainable Development Goals in Europe, but also globally. The E-ROAD works closely with its sister offices around the world to foster development everywhere. All E-ROAD initiatives in Europe will be carried out in cooperation with existing activities of pan-European and national astronomical organisations.

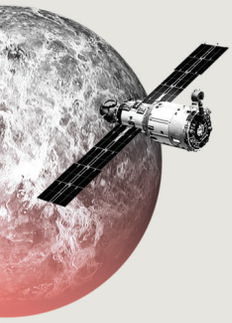
www.astro4dev.eu



Open Science Hub

OSHub.Network is currently establishing an European network of 8 community hubs – OSHubs – , that work as mediators in each local community, positioning schools as active agents for collaboration between families, universities, research institutes, industry, enterprises, media, local governments, civil society organizations, and wider society, by engaging in real-life projects that meet societal needs.

opensciencehub.net



spaceEU

spaceEU is an exciting space outreach and education project which aims to spark the interest of young people in STEAM (Science, Technology, Engineering, Arts and Maths), and to encourage them to consider space-related careers. The project inspires and broadens young minds, develops a sense of European and global citizenship, and through our shared human relationship with space, aims to foster long-term partnerships between people from different countries and cultural backgrounds.

www.space-eu.org

GloabalSCAPE: Global Science Communication and Perception

Science communication is a global field of research and practice central to the relationship between science and society. While recent large-scale studies of science communication have focused on European and Western contexts, the EU-funded GlobalSCAPE project contributes to a more comprehensive picture of science communication by focusing on science communication professionals working in non-Western countries and in regions where science communication can be challenging or under-valued.

global-scape.eu

Social Networking

LAD F Kaiser

Although for many people “the sky's the limit”, we cannot say the same for the members of L.A.D. ‘F. Kaiser’, the association for astronomy students in Leiden. Since we were young, many of us have wondered what goes on beyond the clouds and have an unstoppable curiosity. However, university life can be tough. Stress is a never disappearing component in our lives. And while doing what you love is the most important thing in life, due to endless deadlines, exams and papers you would not be the first to question your love of gaining knowledge.

This is where L.A.D. ‘F. Kaiser’ comes in. As a student association, we strive to bring the fun back into Astronomy. We have different committees that focus on different parts of our association. We have the observing committee that organises observing nights for our members. By letting them experience what it is like to look through an actual telescope, they gain more insight into their studies but also get the chance to experience first-hand how unique their study is. This year we have also brought the historical committee back to life. They focus on the history of the observatory and dive into the archives of the Huygens laboratory to uncover long lost mysteries and stories of the Old Observatory. Next year, they will write a booklet about Kaiser, the Dutch scientist and the association, and about the history of the Old Observatory. Stay tuned for that! However, our committees do not do all the work. We as the board of Kaiser have also organised some activities ourselves. For example, we had an online game night and decorated Christmas cookies together. Moreover, we have organised a talk about the Covid virus with a GGD doctor, activities for the Museumnacht and we helped organise the podcasts of the Werkgroep Leidse Sterrewacht (WLS).

Besides showing our own members how much fun Astronomy can be, we also find it important to show Astronomy to the general public. In a year where conspiracy theories have sometimes gotten the upper hand, we see it as our responsibility to help explain the stories we believe to be true. For example, one of our committees organised another edition of the Spring lectures, this year online, where we explored our own home for a change. Home sweet home, right?

That our home is sweet has been proven once again when Leiden was appointed the City of Science for 2022.

The L.A.D. 'F. Kaiser' board.

We as Kaiser are working hard to contribute to this as well. For example, we are helping with the Museumnacht but are also setting up our own day called “Kaiser-Kapteyn day: The day of the astronomer”. These events will take place in the Old Observatory in 2022. Moreover, we have been working on a telescope training with the WLS that will happen at the end of this year.

Finally, Kaiser also plays an important role in connecting students to the world of the graduated astronomers. Therefore, we keep in contact with the observatory, organise (online) lectures and are improving our contact with the VO-S by organising more activities with them. An example is the mentor lunch where students got the chance to ask questions and make connections. We are planning on further improving this connection in 2022.

To make the above activities possible, L.A.D. ‘F. Kaiser’ has a board which changes every year in August.

The 2020/2021 board consists of Hannah van Gemert *(chairwoman)*, Tessa Paauw *(secretary)*, Christian Groeneveld *(treasurer)*, Sharon Diamant *(vice-chairwoman / assessor Old Observatory)* and Jonathan Pilgram *(assessor Old Observatory)*.

The 2019/2020 board consists of Carmen Turner *(chairwoman)*, Hannah van Gemert *(secretary)*, Christian Groeneveld *(treasurer)*, Rick Dullaart *(vice-chairman / assessor Old Observatory)* and Jort Boxelaar *(assessor Old Observatory)*.

L.A.D. ‘F. Kaiser’, Paint activity based on the Old Observatory exhibition “Shared Sky”.

VO-S the Leiden Observatory Alumni Association

The Vereniging van Oud-Sterrewachters ("VO-S") is the Leiden Observatory alumni association. In 2021, most of the general activities could not take place in person.

The VO-S organises several activities during the year for (under)graduates and staff that have left Leiden Observatory, not only to keep social ties between alumni alive, but also to feed their general interest in astronomical research. Due to the impact of the Covid-19 pandemic, however, most of the activities of 2021 had to be cancelled or postponed (such as the Oort borrel and mentor activities).

Despite this, on 27 November the VO-S members joined online via Zoom for the Annual General Meeting – originally scheduled as an in person meeting at the Old Observatory, it was changed to an online meeting due to Covid-19 restrictions. One benefit was that members who live far from Leiden could also participate. The invited speaker was Michiel van Haarlem, head of the SKA office in the Netherlands. He presented an interesting overview of the status, plans and Dutch involvement in the SKA.

Annual General Meeting of the 2021 VO-S.

Three board members of the 2021 VO-S.

Join the VO-S!

The association has nearly 150 members, with membership open to all Leiden Observatory alumni and staff.

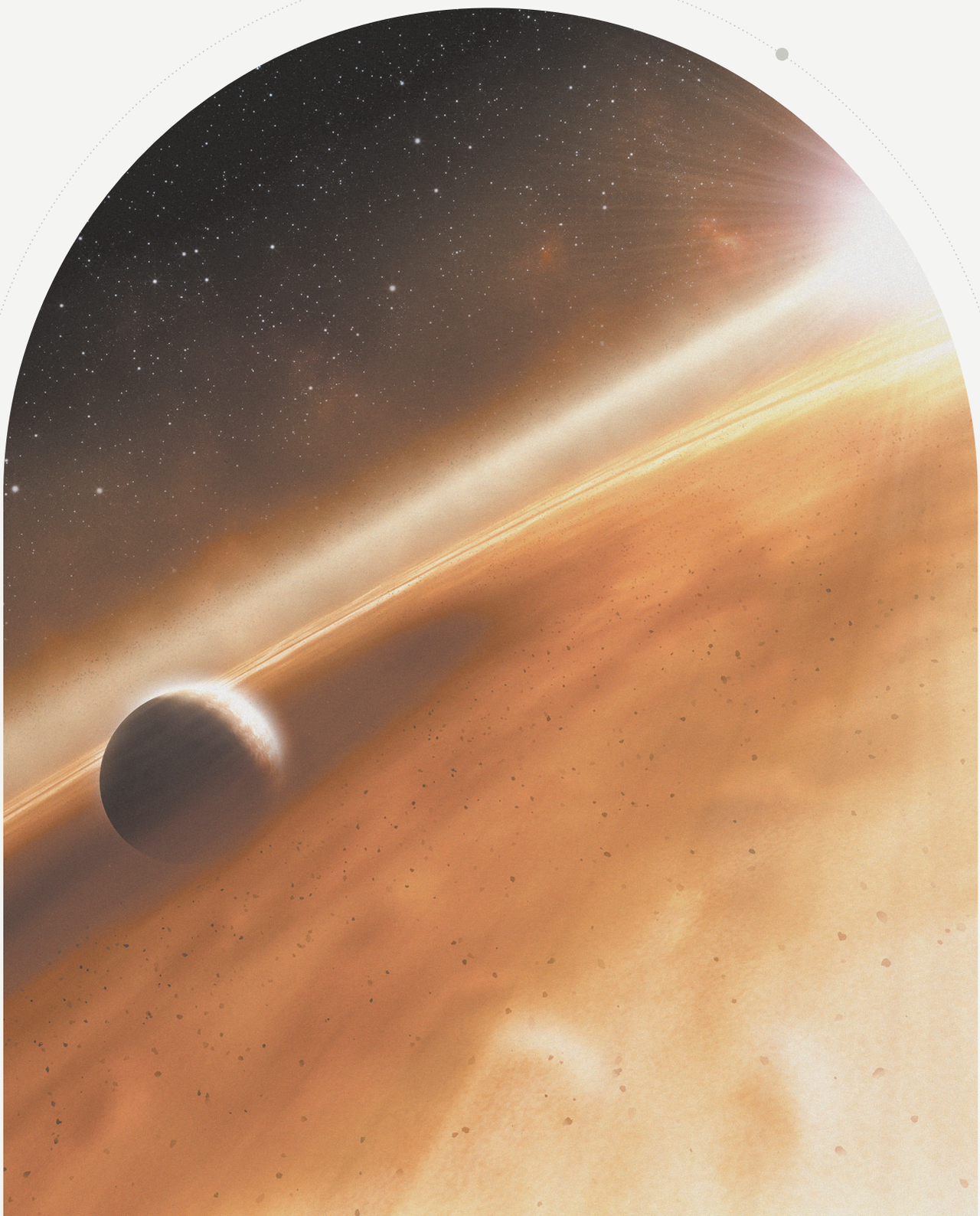
For contact and membership of our alumni association:

- visit our website: http://www.vo-s.nl
- send an email: vo-s@strw.leidenuniv.nl

VO-S Committee:

- Niels van Weeren *(chair)*
- Maaike Damen *(secretary)*
- Gerben Zwart *(treasurer)*
- Anthony Brown *(Leiden Observatory liaison)*

Organisation



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G. Vermarien, BSc

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Prof.dr. S. Viti
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S. Verhoeven

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W. Mulder, MSc

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Dr. R.J. Bouwens

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M.J.C. Wilhelm, MSc
M. Willebrands, MSc

LEAPS ORGANIZERS

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Dr. A. Booth
Dr. O. Hall
Dr. S.K. Leslie *(chair)*

NOVA

NOVA OFFICE

F. van Brenk
Financial controller

Prof.dr. E.F. van Dishoeck
Scientific director

C.W.M. Groen
Financial controller

Dr. F. Helmich
Office manager ad interim (guest)

H. Olgun
Financial administrator

J.T. Quist
Management assistant

Dr.ir. M. Rodenhuis
Instrumentation coordinator

Dr. R. Stark
Executive director

METIS PROJECT OFFICE

Ir. F.C.M. Bettonvil
Consortium manager METIS

Dr. L.H. Burtscher
Calibration scientist METIS

J.W. van der Geest
Consortium financial manager METIS

A. Koops
Configuration manager (guest)

Ir. S. Kwast
Product assurance manager METIS (guest)

Dr. J.A. Lynn
Project manager (guest)

C. Salo
Deputy systems Engineer METIS

Dr. R. Stuik
METIS AIV System Lead

Science policy functions and University Committee Memberships

DR. R.J. BOUWENS

Dutch time allocation panel for the telescopes on La Palma	*Member*
Euclid Science Ground Segment, OU-NIR	*Deputy Coordinator*
SOC for the Rise and Shine Meeting, Strasbourg, France	*Member*
BUFFALO team	*Member*
MUSE GTO team	*Member*
XDF team	*Member*

PROF. DR. B.R. BRANDL

METIS (mid-IR instrument for the E-ELT)	*PI*
MIRI (mid-IR instrument for the JWST)	*Deputy co-PI*
NOVA Instrument Steering Committee (ISC)	*Member*
ESO Contactcommissie	*Member*
ESO's ELT Project Science Team	*Member*
SOC, "Science Enabled by Novel Infrared Instrumentation"	*Chair*

DR. A.G.A. BROWN

Gaia/Netherlands	*PI*
IAU Commission A1	*President*
Gaia Data Processing and Analysis Consortium	*Chair*
Scientific Organizing Committee for the IAU GA XXXI Focus Meeting “Astrometry for 21st Century Astronomy”	*Chair*
Gaia Science Team	*Member*
International Earth Rotation and Reference Systems Service	*Associate Member*
Steering Committee IAU Division A	*Member*
Executive Board GENIUS FP7-Space Collaborative Project	*Member*
NOVA Instrument Steering Committee	*Member*
Steering Committee MW-GAIA COST Action	*Member*
Scientific Organizing Committee for Gaia Symposium at EAS 2021 meeting	*Member*
Writing team for the “Roadmap Thematic Digital Competence Centers” for the domain Natural and Engineering Sciences (NWO)	*Member*
Faculteitsraad	*Member*
Faculty Council	*Member*

DR. L. BURTSCHER

SOC Lorentz Workshop "The Next Generation of Thermal-IR Astronomy"	*Chair*
EAS sustainability committee	*Co-Chair*
Galaxy Coffee	*Co-initiator and co-organiser*
EAS 2020 meeting	*Co-organiser / head of "green LOC"*

METIS calibration working group	*Lead*
Astronomers for Planet Earth operations group	*Member*
ESO OPC P108 panel	*Member*
GATOS collaboration	*Member*
Institute council	*Member*
IR 2022 conference SOC	*Member*
LLAMA collaboration	*Member*
MATISSE commissioning team	*Member*
MATISSE science group	*Member*
METIS science group	*Member*
Ph.D. selection committee	*Member*
Review board, Office of Astronomy for Development	*Member*
RvdA sustainability committee	*Member*
EAS 2020 and 2021 meeting	*Member*
AGN meeting	*Organiser*
Sustainability committee	*Chair*
METIS science team	*Theme lead AGN*

DR. M. VAN DAALEN

MSc admission committee	*Member*

PROF. DR. E.F. VAN DISHOECK

A-ERC PE9 panel	*Chair*
Annual Reviews of Astronomy & Astrophysics	*Co-Editor*
European JWST-MIRI consortium	*Co-PI*
Fundamentals of Science profile area Leiden University	*Coordinator*
Gebiedsbestuur Exacte Wetenschappen (GB-E) Science policy functions	*Member*
National Committee on Astronomy (NCA)	*Member*
NWO Permanente Commissie Grootschalige Wetenschappelijke Infrastructuur	*Member*
Raad van de Astronomie	*Member*
Steering commitee NCCR PlanetS Switzerland	*Member*

PROF. DR. M. FRANX

Leids Sterrewacht Fonds	*Chair board of directors*
Oort Fonds	*Chair board of directors*
Wetenschappelijke Raad	*Chair*
Strategy committee	*Member*
Research committee	*Chair*
Stafflunch meetings	*Chair*
MUSE Science Team	*Member*
Ultravista Survey	*Co-PI*
Lega-C team	*Member*
NIRSPEC/JWST Instrument Science Team	*Member*
KNAW	*Member*
Nova Research Committee	*Member*
Leids Kerkhoven Bosscha Fonds	*Director*

DR. E. DEUL

Institute Council	*Chair*

PROF. DR. M. FRIDLUND

Management Team	*Member*
CHEOPS Science Team	*Member*

PROF. DR. M.R. HOGERHEIJDE

Education Committee Astronomy BSc	*Chair*
ALMA Regional Center Coordinating Committee	*Member*
Board of Directors, Jan Hendrik Oort Fonds	*Member*
Board of Directors, Leids Kerkhoven- Bosscha Fonds	*Member*
Board of Directors, Leids Sterrewacht Fonds	*Member*
European ALMA Regional Center Coordinating Committee	*Member*
European Science Team Origins Space Telescope	*Member*
German SOFIA Time Allocation Committee	*Member*
MATISSE Science Group	*Member*
Allegro, European ALMA Regional Center node in the Netherlands	*Program Director*
Nova Research Committee	*Member*
Leids Kerkhoven Bosscha Fonds	*Director*
SOC Lorentz Workshop “Physical characteristics of normal galaxies at z>2”	*Member*
SOC Oort Workshop “Feedback in galaxy formation”	*Member*
JCMT Large Proposal	*Referee*

PROF. DR. H. HOEKSTRA

Lorentz Center Astronomy Advisory Board	*Chair*
SOC "A century of gravitational lensing", July 11-15	*Chair*
Euclid Cosmology Science	*Coordinator*
NOVA network 1	*Coordinator*
Euclid Cosmology	*Cordinator*
Euclid Consortium Coordination Group	*Member*
Euclid Consortium Editorial Board	*Member*
LISF	*Member*
Lorentz Center Astronomy Advisory Board	*Member*
NWO Vidi grant selection committee	*Member*

DR. J.A. HODGE

Licentiate seminar of Judit Fogasy	*Chair*
Diversity committee Science policy functions and University Committee Memberships	*Member*
ESO OPC	*Member*
Next Generation Very Large Array (ngVLA) High-redshift Universe working group	*Member*
NL-LAC	*Member*
Origins Space telescope Galaxy Evolution Science Working Group	*Member*
SKA Extragalactic Spectral line working group	*Member*
SOC for SMG20 conference	*Member*

PROF. DR. V. ICKE

Advisory Board of CAMRAS (Dwingeloo)	*Member*
Advisory Board of the Institute for Interdisciplinary Studies (University of Amsterdam)	*Member*
Advisory Council	*Member*
Board of Editors of the Nederlands Tijdschrift voor Natuurkunde	*Member*
Board of Regents of the Gerrit Rietveld Academie (Amsterdam)	*Member*

PROF. DR. F.P. ISRAEL

NWO Top-1 Panel Chair	*Chair*
Skepsis Foundation	*Chair*
Nationale Wetenschaps Agena (NWA-ORC)	*Member*
Mid-term review-commissie onderwijs Natuur- en Sterrenkunde	*Member*

PROF. DR. W.J. JAFFE

Veni Selection Committee	*Chair*
European Interferometry Initiative	*Dutch Member*
IAU FITS working group	*Member*
Various IAU scientific committees	*Member*
VENI selection committee	*Member*
MATISSE Project	*Scientist*

PROF. DR. J.S. KAASTRA

Athena science working group WHIM	*Chair*
AGN Science team Arcus	*Lead*
Athena XSAT team	*Member*
Editorial board, Astrophysics & Space Science	*Member*
Hitomi Science Advisory Committee (On behalf of ESA	*Member*
KRISM Science team	*Member*
SOC ICAMDATA 2020	*Member*
XRISM Science team	*Member*
Chandra Low Energy Transmission Grating Spectrometer (NASA)	*Principal Investigator*
XMM-Newton Reflection Grating Spectrometer (ESA)	*Principal Investigator*
XRISM Atomic data team	*Vice-Chair*

PROF. DR. C.U. KELLER

NWO program on Planetary and Exoplanetary Science (PEPSci)	*Co-Coordinator*
Origins Center	*Council Member*
Board, Europhysics News	*Member*
Board, Isaac Newton Group of Telescopes	*Member*
Editorial board of the journal Astronomische Nachrichten	*Member*
ELT Project Science Team, ESO	*Member*
EPA Network Task Group on Citizen Science	*Member*
NWO VIDI grant selection committee	*Member*
Project Science Team, ESO	*Member*
Isaac Newton Group of Telescopes	*Member*

DR. M.A. KENWORTHY

bRing Project	*Principal Investigator*
Coronagraph design for ERIS	*Lead*
High Contrast Imaging for METIS	*Manager*
NASA and NSF	*Reviewer*
JWST Cycle 1 Review Panel	*Member*
PEPSci-II	*Member*
NWO VIDI grant selection committee	*Member*

PROF. DR. K.H. KUIJKEN

Kapteyn Fonds (Groningen)	*Board Member*
Physics Society Diligentia (the Hague)	*Board Member*
Steering committee National Science Agenda, “Time and matter”	*Member*
Steering committee National Science Agenda, “Building Blocks of Space, time and matter"	*Member*

Netherlands Committee for Astronomy	*Member and Vice-Chair*
KNAW council for Natural and Technical Sciences	*Member at large*
ESO KiDS Survey	*Principal Investigator*
Kilo-Degree Survey	*Principal Investigator*

PROF. DR. H. LINNARTZ

IAU division "Laboratory Astrophysics"	*Board Member*
SOC "Molecular high resolution spectroscopy symposium"	*Board Member*
OC Astronomy (Leiden)	*Chairman*
Ice Age - JWST ERS DD program	*Co-PI*
Detection of Extraterrestrial Biosignatures and Organics (PEPSci)	*Coordinator*
Solid state theme NWO-EW/CW 'DAN' (Dutch Astrochemistry Network)	*Coordinator*
Journal for Molecular Spectroscopy	*Editorial Board Member*
Holland Research School for Molecular Chemistry	*Group Leader*
Biomarker theme coordinator within the Planetary and Exo Planetary	*Member*
Board of IAU subdivision Laboratory Astrophysics	*Member*
Editorial board "Journal of Molecular Spectroscopy"	*Member*
FMD/ELD user committee	*Member*
HRSMC research school / since 2005	*Member*
International advisory committee ECOSS 2018	*Member*
NWO-CW 'Spectroscopy and Theory'	*Member*
WN committee OC chairmen	*Member*
Numerous Journals and Science Organizations	*Reviewer*
XII / IAU commission 14 / working group solids and their surfaces	*Vice chair*
FOM group FOM-L-027	*Workgroup Leader*
H2020 ITN EUROPAH	*Workgroup Leader*

DR. J. LUB

Astronomy & Astrophysics Board	*Chairman*
Faculty Library Committee	*Member*
Dutch Astronomical Society (NAC)	*Treasurer*

PROF. DR. F.H. VAN LUNTEREN

History of Science Society	*Member*
Advisory editor Isis	*Member*
Bestuur Stichting Vrienden van de Leidse Universiteitsbibliotheken	*Member*
Committee on Meetings and Programs van de Amerikaanse History of Science Society	*Member*
Descartes Centre Utrecht	*Member*
Gastschrijvercommissie Universiteit Leiden	*Member*
Historisch Genootschap Amsterdam	*Member*
Koninklijk Nederlands Historisch Genootschap	*Member*
Koninklijke Hollandse Maatschappij van Wetenschappen	*Member*
Redactie Nederlands Tijdschrift voor Natuurkunde	*Member*
Studium Generale-commissie Universiteit Leiden	*Member*
Teylers Tweede Genootschap	*Member*
Wetenschappelijke Raad Museum Boerhaave	*Member*
Wetenschappelijke Raad Scaliger Instituut	*Member*
Wetenschapscommissie Teylers Museum	*Member*
Woensdagavond Gezelschap Utrecht	*Member*

DR. Y. MIGUEL

Ariel mission	*Co-PI*
Atmospheric Chemistry working group of the ARIEL mission	*Chair*
Juno mission science team	*Member*
Plato mission science team	*Member*
LIFE space mission concept	*Member*
Young Academy Leiden	*Member*
Outreach committee at the Young Academy Leiden	*Chair*
Policy group of the Young Academy Leiden	*Member*

PROF. DR. G.K. MILEY

Greenberg Foundation	*Chair*
LOFAR Survey Science Group	*Chair*
Organising Committee, Visit to Leiden	*Chair*
IAU European Regional Office of Astronomy for Development	*Co-Chair*
Advisory Committee, Dublin Institute for Advanced Studies	*Member*
Board of Governors of the LOFAR Foundation	*Member*
ERC Synergy Proposals Panel	*Member*
European Research Commission Advisory Panel	*Member*
Raad van Toezicht Stichting LOFAR	*Member*
South African Astronomy Advisory Committee	*Member*
South African Astronomy Advisory Council	*Member*
University and Oort Professorship for South African Minister of Science and Technology, H.E. Naledi Pandor	*Member*
Associated Universities Inc. (AUI- managing body of US National Radio Astronomy Observatory)	*Trustee*
Associated Universities Inc. (Governing body of US NRAO)	*Trustee*

DR. A. MONREAL IBERO

2021 FONDECYT Regular Competition (ANID, Chile)	*External Reviewer*
MUSE Science Team	*Member*
Toelatingscommissie Sterrenkunde BSc	*Member*

PROF. DR. S.F. PORTEGIES ZWART

Netherlands	*Beta Ambassador*
AMUSE development team	*Chair*
Prieneke van Hoeve fellowship selection committee	*Chair*
Springer Journal of Computational Astrophysics and Cosmology	*Editor*
Meta Institute for Computational Astrophysics	*European Ambassador*
Computational Science board	*Member*
ERC synergy grant programme review board	*Member*
Hubble Fellow selection committee	*Member*
IAU Division VII Commission 37 Star Clusters \& Associations	*Member*
KHMW	*Member*
PRACE	*Member*
VPRO Noorderlicht	*Member*
IAU commission C.B1 Computational Astrophysics	*President*

DR. E.M. ROSSI

LOFAR surveys: Opening up a new window on the Universe	*PI*
Board of the Netherlands Research School for Astronomy	*Chair*
Euclid (ESA's dark energy satellite mission) consortium board	*Chair*
LISA Science Group in the LISA Consortium	*Chair*

XIPE's "tidal disruption event" working group	*Co-leader*
Advisory board Delft University Space Institute	*Member*
Board Holland Space Cluster	*Member*
Board LOFAR International Telescope	*Member*
CAN (committee for astroparticle physics in the Netherlands)	*Member*
European leader of the LISA consortium's work package "multimessenger astrophysics"	*Member*
Leiden university wide committee on policies related to top-researchers	*Member*
Netherlands Committee for Astronomy	*Member*
NL-SKA contact committee	*Member*
Science Advisory Committee ASTRON	*Member*
SKA Science working group on radio continuum surveys	*Member*
SRON Scientific Advisory Committee	*Member*

PROF. DR. H.J.A. ROTTGERING

Board of the Netherlands Research School for Astronomy	*Chair*
Euclid (ESA's dark energy satellite mission) consortium board	*Chair*
Advisory board Delft University Space Institute	*Member*
ALMA Proposal Review panel for Cosmology	*Member*
Board Holland Space Cluster	*Member*
Board LOFAR International Telescope	*Member*
Board of directors of the faculty of Science	*Member*
Curatorium of the professorship at Leiden University "Experimental Astroparticle physics"	*Member*
Leiden university wide committee on the promotion of scientific excellence and talent policy	*Member*
Netherlands Committee for Astronomy	*Member*
NL-SKA contact committee	*Member*
Science Advisory Committee ASTRON	*Member*
SKA Science working group on radio continuum surveys	*Member*
Steering Group relocation SRON to Zuid- Holland	*Member*
LOFAR surveys: Opening up a new window on the Universe	*PI*

DR. P. RUSSO

European Commission's H2020 Expert	*Member*
IAU Division C Education, Outreach and Heritage	*Member*
IAU Working Group: IAU 100	*Member*
IAU Commission C2: Communicating Astronomy with the Public	*President*

PROF. DR. J. SCHAYE

MUSE QuBES (Quasar Blind Emitter Survey)	*PI*
MUSE GTO team	*Builder*
LOC "Computational Cosmology"	*Chair*
Athena X-IFU	*Co-I*
LOFAR Epoch of Reionization science team	*Member*
Athena X-IFU science advisory team	*Member*
Board, Pastoor Schmeits prize	*Member*
Consortium board ITN BiD4BEST	*Member*
EUCLID cosmological simulations working group	*Member*
SOC Virgo Consortium for cosmological supercomputer simulations	*Member*
Scientific Organizing Committee, Dwingeloo	*Member*

SOC "The epoch of galaxy quenching"	*Member*
WEAVE QSO science team	*Member*
WeCO (Permanent committee for academic practice of the faculty of science)	*Member*
WT8 fellowship panel Research Foundation Flanders (FWO)	*Member*
Pastoor Schmeits prize	*Member*
Stichting Studiefonds J.C. Kapteyn	*Member*
MUSE (Multi Unit Spectroscopic Explorer)	*Member*
Virgo Consortium for cosmological supercomputer simulations	*Member*

PROF. DR. I.A.G. SNELLEN

NWO Astonomie Tafel	*Vice-Chair*
ERC Starting Grant Committee	*Member*
HIRES/E-ELT consortium	*Member*
METIS Science Team	*Member*
NWA, Route 4 committee	*Member*
NWO Astonomie Tafel	*Member*
PLATO consortium	*Member*
Student travel fund of Leiden University Fund (LISF)	*Member*
EU ERC grant proposal	*Referee*
EU FP7 Network progress	*Reviewer*
Board of Dutch Astronomy Society (NAC)	*Member*
Editorial Board	*Member*
METIS Science Team	*Member*
NWA	*Member*
PLATO consortium	*Member*
EU ERC grant proposal	*Referee*
EU FP7 Network progress	*Reviewer*

DR. IR. F. SNIK

Nederlands Tijdschrift voor Natuurkunde	*Editor*
De Jonge Akademie	*Member*
Isaac Newton Group of Telescopes Time Allocation Committee	*Member*
Nationaal Platform Open Science project Citizen Science	*Member*
NOVA Instrument Steering Committee	*Member*
UL working group Open Science	*Member*

DR. R. STUIK

JHOF	*Secretary*

PROF.DR. A.G.G.M. TIELENS

Science Advisory Committee of SRON	*Chair*
AstroPAH	*Editor in Chief*
Molecular Astrophysics	*Editor in Chief*
European Space Sciences Committee	*Member*
KNAW	*Member*

DR. A. VIDOTTO

IAU commission F2 "Exoplanets and the Solar system"	*Member*
Ariel Working Groups "Upper Atmospheres" and "Stellar Activity"	*Member*
Athena mission topical panel "SWG 3.1 Solar system and exoplanets"	*Member*

Bcool consortium	*Member of the Steering Committee*
SOC of “A high-energy view of exoplanets and their environments", XMM-Newton workshop	*Member*

PROF. DR. S. VITI

Artificial Intelligence committee (FWN)	*Member*
IAU Membership Committee	*Member*
MQAAAstro Advisory Board	*Member*
SKA Core Group Cradle of Life	*Member*
ENW VICI 2021	*Member of the panel*
ESO OPC	*Vice-Chair*

DR. R. VAN WEEREN

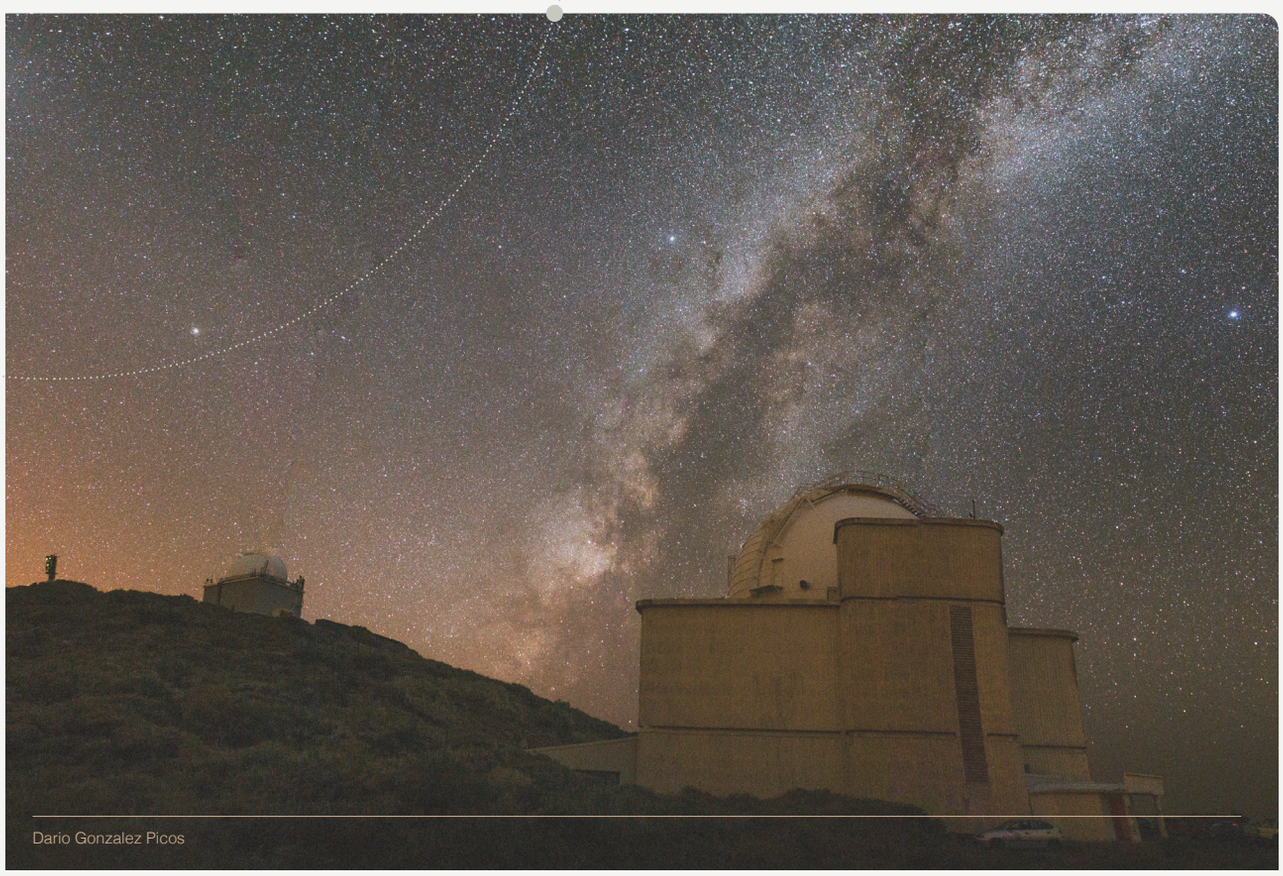
LOFAR Surveys Science Team	*Core Member*
LOFAR Cluster Working Group	*Lead*
LOFAR2.0 Science Advisory Panel	*Member*
Lorentz Center science board	*Member*
NWO Astonomie Tafel	*Member*
SKA Continuum Science Working Group	*Member*
Astronomy board Lorentz Center	*Member*

PROF. DR. P.P. VAN DER WERF

European Science Advisory Committee for ALMA (ESAC)	*Chair*
MIRI	*Co-investigator*
ALMA Spectroscopic Survey consortium	*Member*
ALMA-LABOCA ECFS Survey consortium	*Member*
Board of Admission's Master's Program	*Member*
ESO Scientific and Technical Committee (ESAC)	*Member*
Herschel Astrophysical Terahertz Large Area Survey consortium	*Member*
METIS Science Team	*Member*
STFC Herschel Oversight Committee	*Member*
Task Force Strenghtening Master Programmes	*Member*
Academy Auditorium	*Organist*
DESHIMA spectrograph	*Principal Investigator*
JCMT Cosmology Legacy Survey	*Principal Investigator*
AMKID submillimeter camera	*Project Scientist*
ALMA Scientific Advisory Committee (ASAC)	*Vice-Chair*

PROF. DR. T. DE ZEEUW

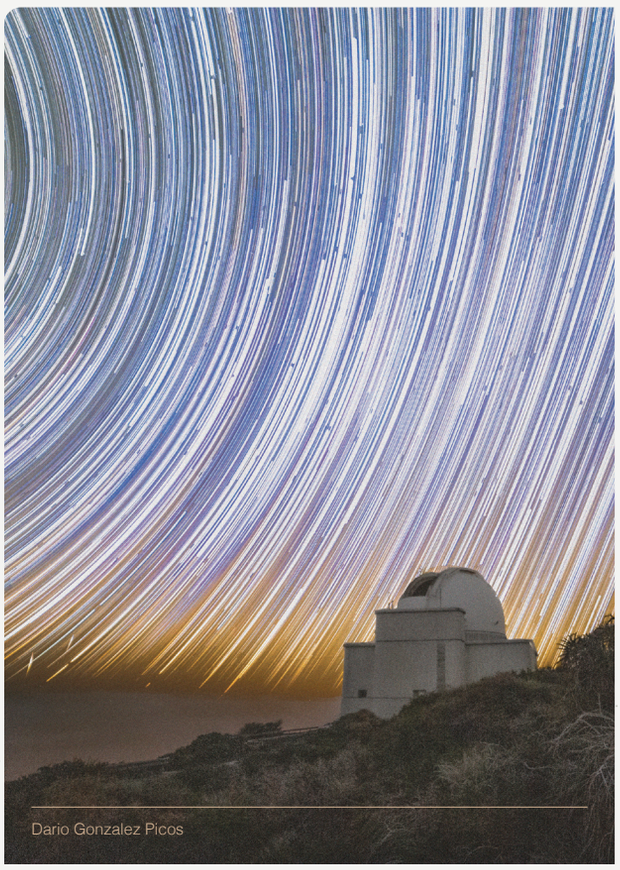
International Advisory Board, ASTRO3D Consortium, Australian Research Council, Canberra	*Chair*
Steering Committee ASTRO2020, National Academy of Science, Washington	*Member*
Advisory Board, NWO, The Netherlands	*Member*
Stiftungsrat Heidelberg Institut for Theoretical Studies	*Member*
Legacy Fellow of the American Astronomical Society	*Member*



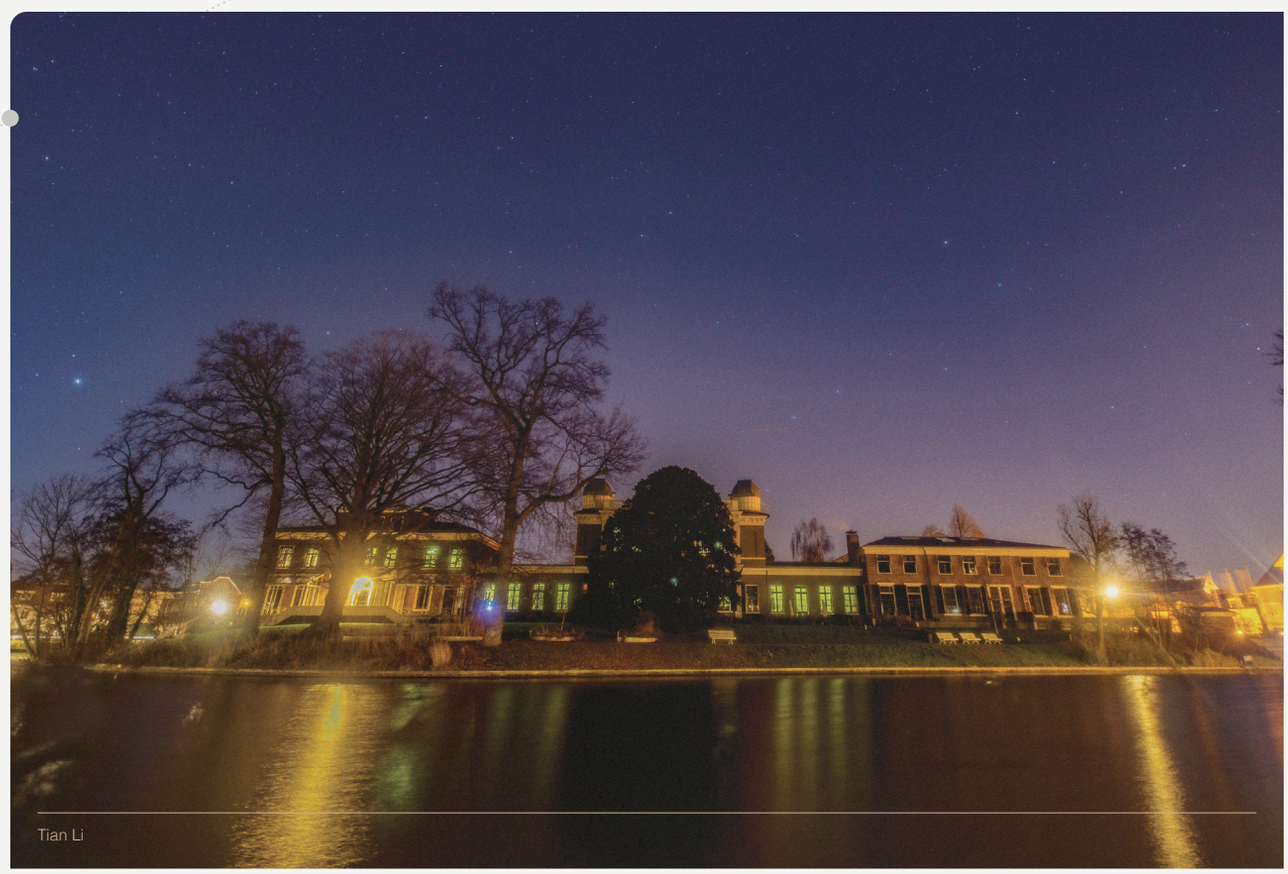
Dario Gonzalez Picos

Tian Li

Dario Gonzalez Picos



Dario Gonzalez Picos



Tian Li

Grants

Old Observatory in Lego. Inventor, builder, copyright and credit Uwe Hensch

Grants 2021

P.I.	FUNDER	PROPOSAL TITLE	BUDGET (k€)
Keller	NWO	*FREE – Optical Wireless Superhighways: Free photons (at home and in space)*	525
Snik/Russo	KNAW	*Pilotfonds Wetenschapscommunicatie door wetenschappers: Gewaardeerd!*	20
Sellentin	LUF – Prieneke van Hoeve en Trigt fonds	*Deblending for LSST weak lensing & skin cancer detection*	200
Russo	International Commission for Optics (ICO)	*International Day of Light*	20
Van Dishoeck	EU	*Linking chemistry and physics in the planet-forming zones of disks*	2282
Vidotto	EU	*The influence of stellar outflows on exoplanetary mass loss*	1334
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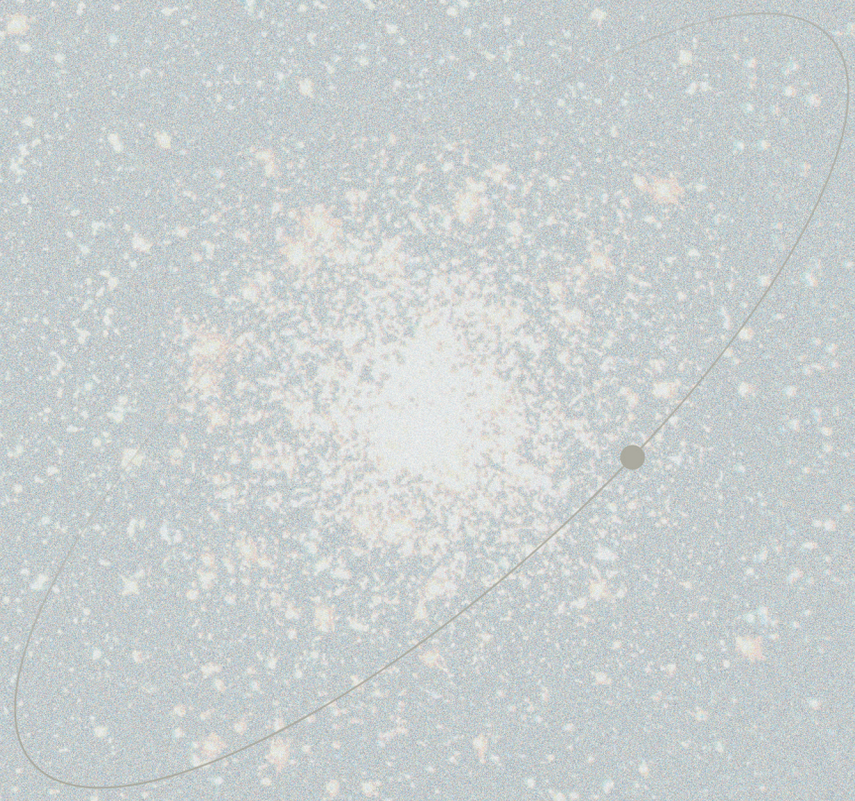

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