

Faculty of Science and Engineering

Profile report: Planetary Atmosphere Sciences / Planeet Atmosferen

- Discipline: Astrochemistry, Exoplanets
- Level: Tenure-track assistant professor
- Focus domain: Research
- FTE: Full time (1,0)

1. Scientific discipline

In the past decade, we moved from an era of detecting extrasolar planets into characterizing them and studying their atmospheres. Existing new facilities at near- and mid-infrared wavelengths such as JWST, VLT/SPHERE(+), GRAVITY, provide new insights also into the formation and evolution of potentially habitable worlds. JWST spectroscopy is opening a new dimension of atmosphere studies, pushing down to studying the characteristics of rocky planets as well as bringing exoplanet climate studies into reach. The next 5–10 years will see enormous observational advances, both from the ground (ELT/METIS) and from space (PLATO, ARIEL), leading up to a next-generation direct imaging space mission (HWO/LIFE) that will characterize the diversity of terrestrial exoplanet climates and search for extra-terrestrial life. The availability of these new tools offers novel ways – that were impossible until now – to make major leaps forward in this field.

2. Vacancy

The Board of the Faculty opens this position in the context of the “Sectorplannen Astronomy”. The position will be embedded in the Kapteyn Astronomical Institute. The position falls within the framework of ‘Career Paths in Science and Engineering (‘Bèta’s in Banen’ version 5; June 1, 2023). Please see the link for the [criteria and conditions](#).

3. Selection committee (BAC)

The proposed BAC is composed of:

- Prof. dr. Leon Koopmans (Chair; Scientific Director)
- Prof. dr. Rien van de Weygaert (Education Director, repr. USS), RUG
- Prof. dr. Inga Kamp [W], RUG
- Prof. dr. Floris van der Tak, RUG/SRON
- dr. Tim Lichtenberg, RUG
- External member [TBC]
- Marloes van Asselt (MSc student, chair of the board of Sirius A), RUG [TBC]

Advisors:

- o dr. L. van der Voort (Scientific Coordinator Kapteyn)
- o Femke Postma (HR advisor) [TBC]

Profile report:

4. Research area

The profile of the candidate should be such that it strengthens NOVA Network 2 (NW2) “Formation and evolution of stars and planetary systems” at the Kapteyn Astronomical Institute. The NOVA evaluation in 2016 stated that NW2 is subcritical in Groningen, with one staff member at Kapteyn and one zero appointment (SRON). Our strategy is to expand NW2 in Groningen in the direction of the formation, characterization and evolution of planetary systems, aligning with the key research focus of NOVA and its instrumentation program and our curriculum needs. To this extent, one new staff member was hired last year, Tim Lichtenberg on planetary sciences. Within this context, we aim also for this new position for a profile that is highly complementary to the exoplanet search studies going on at the universities of Leiden, Amsterdam, and the NWO institutes ASTRON and SRON, yet fill an important gap in Kapteyn's current research portfolio. The research focus of this new staff member should be on exoplanet atmospheric science bridging between astrochemistry expertise present (Prof. Dr. van der Tak, Prof. Dr. Kamp) and planetary sciences (Dr. Lichtenberg). This focus also aligns with the bright future of this topic sketched in the recent Astro2020 (US decadal survey), ASTRONET Roadmap 2022-2035 and Voyage2050 (ESA) reports.

Within the Dutch community (NW2), we aim to link the diversity of planet-forming disks to that of the exoplanet population; in Groningen, our strategy is to focus especially on rocky exoplanets. The recently hired staff member Dr. Lichtenberg is an expert on the geophysics and interior of exoplanets, and we foresee the new staff member to collaborate with him with a strong focus on the chemistry of planetary atmospheres. New instrumentation (JWST, ARIEL, PLATO, METIS) will provide the data to map out the diversity of exoplanetary systems and to characterize exoplanets. While the evolution of a planet and its interior composition plays a crucial role in exoplanet atmospheric composition, the prediction of observables such as transit spectra or phase curves requires an extra step of chemical modelling of atmospheric composition. The new staff member is expected to focus on atmospheric composition and dynamics, including photochemistry (upper layers), cloud formation, equilibrium chemistry and atmospheric circulation, and thus to contribute directly to interpreting the observational data. This research will connect to two key themes of the Dutch Origins Center: “The formation and early evolution of Earth-like planets and moons” and “The emergence of the right conditions for the origin of life”. In this context the new staff member is expected to engage in collaborations with other institutes at the Faculty of Science and Engineering (e.g. GBB, GELIFES, Stratingh, Zernike) and with SRON and ASTRON and universities across the Netherlands, in particular Leiden, Utrecht, Amsterdam, and Delft.

The new discipline of exoplanet science generates this unique opportunity to build a bridge between astrophysics, studying the population of exoplanets and characterizing them remotely, and geophysics/solar system planetary sciences, that focus on understanding the diversity and formation history of planets inside the Solar System. To thrive as a transdisciplinary endeavour, this research requires bringing together astrophysical data and planetary mission data and abstracting from the detailed knowledge of solar system planets to the sparsely characterized exoplanets. The new staff member is expected to shape the landscape for future instrumentation, space missions and research initiatives that keeps Kapteyn at the forefront of this transdisciplinary research.

The staff member is anticipated to engage in the international METIS consortium, a first light instrument of the Extremely Large Telescope with strong Dutch involvement (NOVA has the PI role and van der Tak, Kamp are on the science team) which will enable detailed characterization of planetary atmospheres and climates, pushing towards rocky planets. The staff member could also anticipate playing a more prominent role in the European Astrobiology Institute (EAI), an initiative that closely relates to the Dutch Origins Center.

5. Embedding: institute (and base unit)

The Kapteyn Astronomical Institute consists of a single base unit, and therefore the candidate reports directly to the Scientific Director of the Institute. The institute has a vibrant and currently growing number of 18 (16.8 FTE) scientific staff, including a joint staff member with ASTRON, plus 11 affiliated staff (incl. three Honorary Professors) with ASTRON and SRON. The number of PhD students is approximately 60, and the number of postdocs is approximately 25.

The institute focuses on a number of research domains:

- Galaxy Structure, Formation and Evolution (NW1);
- ISM, Star and Planet formation (NW2);
- Cosmology and Large-Scale Structure (NW1);
- High-Energy Astrophysics and Active Galaxies (more minor research themes; NW1, NW3).

Beyond these domains/themes, substantial staff effort is being put into Advanced instrumentation and software, data science and virtual observatories.

The mission of the Kapteyn Astronomical Institute is to perform front-line research in astronomy, astrophysics and related fields, aided by the presence of NWO-institutes ASTRON and SRON, and to provide an excellent educational environment for both graduate and undergraduate studies. The Institute's mission and its policy and strategy are closely linked to and partly define the mission of the Netherlands Research School for Astronomy, NOVA. Research is mainly concentrated on two of three themes of NOVA, namely "formation and evolution of galaxies: from high redshift to the present" and "formation and evolution of stars and planetary systems". In the process of doing this research, scientific staff members are building several instruments for large-scale facilities, both on the ground and in space. They aim to maximally exploit the existing and upcoming instruments scientifically, reaping the rewards of years of dedicated preparation, and to position themselves in scientific and instrument leadership roles in current (e.g. JWST, Gaia, VLT, LOFAR, ALMA, WEAVE) and future instrumentation (e.g. Euclid, 4MOST, ELT, SKA) and to prepare the next generation of young scientists for a future in science and society through high-quality education at the bachelor, master and PhD levels, closely connected to the research done at the institute.

The excellent reputation of the Kapteyn Astronomical Institute has made it possible to attract promising, high-quality astronomers to the University of Groningen. The facilities that the Institute offers, such as world-class observing facilities (e.g., ESO, La Palma, LOFAR), involvement in space missions (e.g. Gaia, Euclid, JWST), data reduction and computing facilities, instrumentation infrastructure, and scientific environment, make the Kapteyn Astronomical Institute a very attractive institute for astronomical research in the world.

The position connects to and strengthens our research focus on "Galaxy Structure, Formation, and Evolution" and our position within Network 1 of the Netherlands Research School for Astronomy, NOVA. It also strengthens our ties to the NOVA Instrumentation Labs, SRON, ASTRON and JIVE, and opens new national/international funding opportunities.

6. Local and (inter)national position

The NOVA NW2 “Formation and evolution of stars and planetary systems” group at the Kapteyn Astronomical Institute at the University of Groningen currently covers expertise on star formation, astrochemistry, planet-forming disks and exoplanet interiors. In this the institute strongly collaborates with groups in Leiden (van Dishoeck, Tielens, Hogerheijde, van der Marel, Viti), Amsterdam (Dominik), Nijmegen (Waters) and SRON (Min, Miguel). Much of the focus in this area within the Netherlands (Leiden and Amsterdam) is on exoplanet detection and characterization studies. With this new position, the institute envisions strengthening the connection to planetary sciences (e.g. TU Delft: Vermeersen, Cazaux) and deepening the existing collaborations with geophysics in Amsterdam (van Westrenen) and Utrecht (e.g. ten Kate, Mason) in the framework of the Dutch Origins Center. NOVA and specifically NW2 has strongly invested in the SPHERE, MATISSE, JWST, ARIEL, PLATO and METIS missions and instruments, and Kapteyn/NOVA will have prime access to the first data detecting young forming planets, enabling the characterization of planetary building blocks and studying super-Earth atmospheres. What the Kapteyn Institute needs to build now is the link between planet formation, planetary interiors and their atmospheres.

7. Expected contributions to research

The candidate will be an expert in exoplanetary atmospheres and evolution. They are expected to be a key player in the exploitation of upcoming JWST, ARIEL, PLATO and METIS data. The expertise will be complementary to Prof. Dr. van der Tak, Prof. Dr. Kamp, and Dr. Lichtenberg who focus on characterizing the stages before planet formation – constraining planetary building blocks –, studying the coupling between planetary interiors and atmospheres, and developing exoplanet atmosphere diagnostics relevant for life. They are expected to develop an interdisciplinary research group linking astrophysics and geophysics and to become a leading member of the Origins Center. The candidate is expected to obtain substantial external funding to contribute to Origins Center-related research and to sustain an active and competitive research group (PhDs and postdocs).

8. Expected contributions to teaching

The BSc/MSc program Astronomy comprises roughly 300 students. The candidate will be expected to teach (primarily) courses such as the Astronomy Bachelors and Masters programs, especially courses such as *Introduction to Astronomy*, *Planetary Systems*, *Interstellar Medium*, *Star and Planet Formation*, *Exoplanets*, *Astrochemistry*, and develop them further. They are also expected to supervise BSc/MSc student projects in the area of star and planet formation, exoplanets, and astrochemistry. Other appropriate courses will be taught as needed by the programs. The candidate will also be actively involved in developing new and ongoing courses.

9. Expected contributions to the organization

The candidate is expected to have an active interest in the running and well-being of the institute and to provide a positive contribution to its management and organisational tasks. At the level of FSE, the candidate will contribute to the organisation of the faculty, for example, by participating in working groups and committees in the fields of teaching, research and management. The candidate will participate in relevant national and international organisations.