

## Faculty of Science and Engineering

### Profile report: *Planetary Sciences / Planeet Onderzoek*

- Discipline: *The physical and chemical characterization of exoplanets*
- Level: *Tenure-track assistant professor*
- FTE: *Full time (1,0)*

### 1. Scientific discipline

The discipline is in the field of Exoplanets, i.e. planets around stars other than our Sun. One of the main aims of this discipline is to understand the process of how planets form from the initial conditions in planet forming discs to produce a diversity of planets, e.g. rocky planets such as Earth, gas-giants such as Jupiter, and icy planets and satellites. The field of exoplanets also studies how these different bodies subsequently evolve and their potential habitability. The discipline is thus highly interdisciplinary by nature, connecting to the fields of geophysics/solar system planetary sciences and to astrobiology. The latter aims at understanding how life forms on planets and under what circumstances life can appear, survive and evolve.

### 2. Vacancy

This position is opened by the Board of the Faculty (*PT/gl/21/00915*) and will be embedded in the Kapteyn Astronomical Institute. The position falls within the framework of 'Career Paths in Science 4' ('Bèta's in Banen 4'). Please see link for [criteria and conditions](#).

### 3. Selection committee (BAC)

The selection committee consists of:

- Prof. Dr. L.V.E. Koopmans (Chair, Scientific Director) , RUG
- Prof. Dr. M.A.M van de Weijgaert (Education Director, representing USS) , RUG
- Prof. Dr. I. Kamp [W] , RUG
- Prof. Dr. S.C. Trager, RUG
- Prof. Dr. F. van der Tak, SRON/RUG
- Prof. Dr. D. Stam [W], Delft University
- Nynke Visser (MSc student, board member of Sirius A), RUG

Advisors:

- Dr. L. van der Voort (Scientific Coordinator Kapteyn)
- L. Boomsma (Senior HR advisor)

#### 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 last NOVA evaluation stated that NW2 is subcritical in Groningen, with one staff member at Kapteyn and one zero appointment (SRON). Today, exoplanet studies are a core NW2 research line, and this is currently a gap in the otherwise broad Groningen astronomy research portfolio/curriculum. Within this context, we aim 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. The research focus of this new staff member should be on physical and chemical characterization of exoplanets. This focus also covers the link between the atmospheres, surfaces and interiors of exoplanets and their long-term evolution (from their formation to Gyr timescales). It also aligns with the bright future of this topic sketched in the recent Astro2020 (US decadal survey) 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, especially of terrestrial exoplanets. While the group of Prof. Kamp works on the former aspect, the new staff member would approach this from the exoplanet perspective. New instrumentation (JWST, ARIEL, PLATO, METIS) will provide the data to map out the diversity of exoplanetary systems and to characterize exoplanets. It is clear that the evolution of a planet and its interior composition plays a crucial role in the understanding and interpretation of exoplanet atmosphere data. The new staff member is expected to focus on understanding what drives the exoplanet diversity and to contribute to interpreting the chemical composition of exoplanet atmospheres. 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 universities across the Netherlands, such as 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 systems 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 systems 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 expected 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 more 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 Centre.

## **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 steady number of research staff members of ~15.8 FTE scientific staff, including 0.5 FTE joint staff with ASTRON plus ~13 adjunct (“zero-appointment”) staff with ASTRON and SRON. The number of PhD students is approximately 50, and the number of postdocs is approximately 30.

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 (smaller research themes; NW1, NW3).

Beyond these domains/themes, substantial staff effort is being put into Advanced instrumentation and software; and 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 mostly concentrated in 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. Their aim is 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 future instrumentation, such as JWST, ARIEL, METIS, CTA, ELT and 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 level, closely connected to the research done at the institute.

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

The position connects to and strengthens our research focus “ISM, Star and Planet formation” and our position within Network 2 of the Netherlands Research School for Astronomy, NOVA. It also strengthens our ties to the Dutch Origins Centre 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 atmospheres. In this the institute strongly collaborates with groups in Leiden (van Dishoeck, Tielens, Hogerheijde), 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 planetary interiors and evolution. S/he is expected to be a key player in the exploitation of upcoming JWST, ARIEL, PLATO and METIS data. The expertise will be complementary to Prof. van der Tak and Prof. Kamp, who focus on characterizing the stages before planet formation – constraining planetary building blocks – and developing exoplanet atmosphere diagnostics relevant for life. S/he is 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 candidate will teach (primarily) in the Astronomy Bachelors and Masters programs, especially courses such as *Introduction Astronomy*, *Numerical Methods*, *Planetary Systems*, *Astrobiology (university minor)*, *Star and Planet Formation*. Other appropriate courses will be taught as needed by the programs. The candidate will also be actively involved in the development of new and ongoing courses, including courses in *exoplanets*, *astrochemistry*, *astronomical data science* and *astronomical detection techniques*.

### **9. Expected contributions to the organization**

The candidate is expected to have an active interest and to provide a positive contribution to the management and organizational tasks of the institute. At the level of FSE, the candidate will contribute to the organization 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 organizations.