Up to 10 PhD Scholarships for joint PhDs in Astrophysics 2024/2025

DEADLINE: 7th August 2024

The Astrophysics Group of Stellenbosch University (SU) and the Kapteyn Astronomical Institute of the University of Groningen (UG) invite applications for up to ten Joint-PhD Scholarships under the joint research chair of computational astronomy. In this application round, projects are available in the following areas:

- Cosmic Filaments and Voids: Gas Content and Flows of Galaxies
- Next Generation Frameworks for the First Billion Years: Synergizing the SKA and Galaxy Facilities
- Morphological Classification in Astronomical Surveys with Convolutional Neural Networks
- The Design and Data Analysis of Radio-Receivers to Detect the Signal of Neutral Hydrogen from the Infant Universe
- Detecting Neutral Hydrogen from the Epoch of Reionization and Cosmic Dawn with HERA and LOFAR
- Cross-Correlating of MeerKAT 21-cm Intensity Mapping Surveys with such as Euclid and LSST
- Probing the Early Universe and Kinetic Sunyaev-Zeldovich Effects with CMB Data Using Machine Learning
- Deep Imaging of Brown Dwarfs/Exoplanets with MeerKAT, LOFAR and Euclid
- Enhancing MeerKAT Data Reliability to Explore Dwarf Galaxies through HI Surveys

Links to more details on these projects, supervisors, and expected backgrounds of the applicants are provided below. If not all ten Joint-PhD Fellowship positions are filled, a second round may be announced.

The Astrophysics Research Group at SU focuses on connecting fundamental physics with astronomical observations to understand the fundamental laws of the Universe and unravel the nature of dark matter and dark energy. Our active research directions include the epoch of reionization, extragalactic astronomy, the early Universe, dark matter indirect detection, neutron stars, and black holes. We are heavily involved in South Africa's MeerKAT, the Square Kilometre Array (SKA), the Hydrogen Epoch of Reionization Array (HERA) telescopes, LSST (Vera C. Rubin Observatory), FAST telescope, and CMB Stage-4. We also use data from the Atacama Cosmology Telescope, South Pole Telescope, ESO's Kilo-Degree Survey (KiDS), and Dark Energy Survey Instrument (DESI).

The Kapteyn Astronomical Institute at UG is part of the Netherlands Research School for Astronomy (NOVA) and is recognised worldwide for its quality research in multiple areas of astronomy. With about twenty faculty members, twenty-five postdocs, and sixty PhD students, it is the second-largest astronomical institute in the Netherlands. Groningen, a historic town in the northern Netherlands, plays a strategic role in Dutch astronomy, hosting both the Kapteyn Astronomical Institute, the low-energy astrophysics division of the Netherlands Institute for Space Research (SRON), and the NOVA sub-mm lab. The Kapteyn Institute has a strong connection with the nearby Netherlands Institute for Radio Astronomy (ASTRON) in Dwingeloo, a European centre of radio astronomy research. There are also strong interdisciplinary connections with other institutes in the Faculty of Science and Engineering and the Dutch Origins Centre. We are heavily involved in e.g. HST/JWST, VLT/ELT, Gaia, KiDS/Euclid, WHT-WEAVE, LOFAR/SKA, ALMA and more.

Criteria

We seek excellent students with a strong background in (astro)physical, engineering, or computer sciences, depending on the specific projects, who desire to obtain a Joint-PhD degree from a top-ranked European and a top-ranked South African university.

To be eligible to apply, a candidate must hold a Master's or equivalent degree in Physics, Astronomy, Engineering, or Computer Science by the starting date of the enrolment (1 January – 31 March 2025). Previous research experience and skills will be important criteria for selection.

English is the common language spoken at both institutes, and proficiency in English is a requirement for acceptance. For more details, see: UG Admission Criteria

The PhD students will be registered at both SU and UG. The students will defend their PhD thesis at the University of Groningen and obtain a Joint-PhD degree from both universities. All PhD positions are fully funded for four years at the level appropriate for their stays in South Africa (around 3 years) and the Netherlands (around 1 year).

More detailed information on the individual projects offered, supervisors, requirements, and how to apply can be found at: UG Kapteyn Institute and SU Astrophysics Group

Informal inquiries are welcome and should be sent to suugastro@gmail.com

Applications: Submit your application here

Application deadline and Selection process
Applications close on 7 August 2024, at midnight (23:59 SAST/CEST).
Short-listing of candidates will continue until all positions are filled.
Interviews of shortlisted candidates are expected to start by 26 August 2024.
Final acceptance of the candidates will be completed by early October 2024.

Compensation and Benefits
In accordance with the regulations while resident at Stellenbosch University and while resident at the University of Groningen. The scholarship value is R 200,000 per year for four consecutive years. During the visiting period at UG (6-12 months), the student will receive an additional monthly top-up to align with the local standard for PhD students in the Netherlands.

Application Details
Publication Start Date: 17 June 2024
Application Deadline: 7 August 2024

Inquiries
Name: Selection committee; Email: suugastro@gmail.com

Projects description:

1) Cosmic Filaments and Voids: Gas Content and Flows of Galaxies

Main supervisors: van de Weygaert (UG), TBC (UG), Ma (SU).

Prerequisites: Preferably a background in astronomy or (astro)physics with good mathematical and coding skills and an affinity with working with data and/or simulations.

Summary: This project focuses on the large-scale structure of the universe, particularly the dynamics of cosmic filaments and voids. The research aims to understand how mass flows out of voids and is channeled through filaments towards clusters, influencing galaxy properties. Utilising MEERKAT and SKA-based 21-cm surveys, the project will study nearby galaxies, examining their properties and peculiar velocities via the Tully-Fisher relation. The analysis will employ advanced formalisms such as MMF/Nexus and the Caustic Skeleton model, applied to cosmological simulations of galaxy formation.

2) Next Generation Frameworks for the First Billion Years: Synergizing the SKA and Galaxy Facilities

Supervision: Dayal (UG), Ma (SU)

Prerequisites: Preferably a background in astronomy or (astro)physics with good mathematical and coding skills and an affinity with working with data and/or simulations.

Summary: This project aims to use the latest Astraeus (numerical simulation) framework, developed in Groningen, as a training dataset for 21-cm facilities like the SKA. The goal is to illuminate the sources of reionization in the simulation and develop statistical tools to extract the first reionization source in the data. The project will combine the expertise of numerical galaxy formation in Groningen and the 21-cm physics at Stellenbosch.

3) Morphological classification in astronomical surveys with Convolutional Neural Networks

Supervisors: Vedantham (UG/ASTRON), Verdoes Kleijn (UG), Koopmans (UG), Wang (SRON/UG), Ma (SU), Grobler (SU)

Prerequisites: Preferably a background in computer and/or data science with good mathematical and coding skills and an affinity with working with data.

Summary: This project aims to advance automated false positive removal, building on existing expertise in astronomical morphological classification at both universities. The PhD student will have access to proprietary LSST and Euclid datasets, benefiting from being at both institutions. This collaboration aims to enhance our ability to identify and study rare celestial objects efficiently.

4) The design and data analysis of radio-receivers to detect the signal of neutral hydrogen from the infant Universe

Supervisors: de Villiers (SU), Yin-Zhe Ma (SU), Koopmans (UG), Meerburg (UG)

Prerequisites: Preferably a background in (electrical) engineering or (astro)physics with good mathematical and coding skills and an affinity with working with instrumentation and data.

Summary: This project involves simulating, designing and testing radio receivers for earth (i.e. REACH currently deployed in South Africa) and space-based mission (e.g. ALO/DEX) to detect line-radiation of neutral hydrogen emitted during the first billion years of our Universe. The project could be tailored to focus on engineering and/or data analysis aspects depending on the strengths and interests of the student.

5) Detecting neutral hydrogen from the Epoch of Reionization and Cosmic Dawn with HERA and LOFAR

Supervisors: Ma (SU), Koopmans (UG)

Prerequisites: Preferably a background in (radio) astronomy or (astro)physics with good mathematical and coding skills and an affinity with working with data.

Summary: This project involves jointly analysing data from HERA and LOFAR to further the understanding of these complex data-sets, containing the spatial and spectral signal of neutral hydrogen emitted from the first billion years of the universe, and help compare their results to advanced numerical simulation of this signal.

6) Cross-correlating of MeerKAT 21-cm intensity mapping surveys with such as Euclid and LSST

Supervisors: Yin-Zhe Ma (SU), Koopmans (UG)

Prerequisites: Preferably a background in (radio) astronomy or (astro)physics with good mathematical and coding skills and an affinity with working with data.

Summary: This project aims to cross-correlate the signal of neutral hydrogen from our nearby Universe observed with MEERKAT with other survey data such as those coming from the Euclid mission and LSST. The project also prepares for future surveys with the SKA.

Note: Possibly 2 PhDs positions available for projects 5 and 6.

7) Probing the Early Universe and kinetic Sunyaev-Zeldovich Effects with Cosmic Microwave Background Data Using Machine Learning

Main supervisors: Ma (SU), Meerburg (UG), Zaroubi (UG)

Prerequisites: Preferably a background in (astro)physics with good mathematical and coding skills and an affinity with working with data and simulations.

Summary: This project aims to analyze CMB (current and Stage 4) data to detect signatures from the early universe and study the anisotropic kinetic Sunyaev-Zel'dovich (kSZ) effect via auto and cross-spectra. Utilising the non-Gaussian nature of the kSZ and by applying advanced machine learning techniques, new insights into cosmic evolution and structure formation will be studied.

8) Deep Imaging of Brown Dwarfs/Exoplanets with MeerKAT, LOFAR and Euclid

Main supervisors: Vedantham (ASTRON/UG), Verdoes Kleijn (UG), Grobler (SU), Ma (SU)

Prerequisites: Preferably a background in (radio) astronomy or (astro)physics with good mathematical and coding skills and an affinity with working with data.

Summary: This PhD project aims to conduct deep imaging of brown dwarfs and exoplanets using MeerKAT and Euclid. The project will focus on imaging techniques and can also have an astrophysics component to investigate the magnetic fields and atmospheres of brown dwarfs and free-floating planets

9) Enhancing MeerKAT Data Reliability to Explore Dwarf Galaxies through HI Surveys

Main supervisors: Adams (ASTRON/UG), de Blok (ASTRON/UG), Grobler (SU), Ma (SU)

Prerequisites: Preferably a background in (radio) astronomy or (astro)physics with good mathematical and coding skills and an affinity with working with data.

Summary: This project starts with quantifying uncertainties in source detections algorithms by injecting signal in the MeerKAT data, but at a much earlier stage than commonly done. This will help quantify the impact of calibration and deconvolution procedures on faint HI signals. This will be used to enable robust searches, potentially using machine learning, for faint dwarf galaxies in MeerKAT HI data. The total baryonic content of these small galaxies will be compared to their dark matter halo mass to understand how baryonic and dark matter trace each other in the low-mass regime.