Project Title:

OPTICAL ANALYSIS OF SPACE ICES

Project description:

This project involves laboratory experiments to characterize the optical properties of ices in space. Such ices play an important astrochemical role, for example in the formation of new molecules in the interstellar medium. They also determine the chemical composition of newly forming planets. Without a good knowledge of refractive indices and scattering coefficients, e.g. as function of ice mixture, temperature and level of porosity, it is hard to interpret astronomical observations.

In the Laboratory for Astrophysics at Leiden Observatory (the Netherlands) one of the largest academic observatories in the world, a fully operational setup is available to perform broadband interferometric experiments on cryogenic ices (10K). The goals of this PhD project are: i) systematically measure optical properties of a number of astronomically relevant ices, ii) to interpret these properties by linking them to the underlying ice morphology, and iii) to apply the results investigating astronomical data.

Supervisor:

Prof. dr. Harold Linnartz; dr. KoJu Chuang

Selection criteria:

You have a background in experimental physics or physical chemistru. You have experience with handling vacuum and optical equipment and you are interested in astronomy. Good English skills are an absolute prerequisite, both oral/written.

Applications:
To apply for this vacancy, please send an email to linnartz@strw.leidenuniv.nl. Please ensure that you upload the following additional documents quoting the project title:

- Curriculum vitae;
- Bachelor's and master's transcripts;
- (Draft of) MSc thesis;
- Names of 2 persons we could contact for a letter of recommendation

Deadline: March 1st 2021

Project Title: Radio feedback and the evolution of galaxies and their massive black holes

Project description:

Unravelling the evolution of galaxies and their central massive black holes, from the 'dark ages' to the variety of systems that we observe in the local Universe, remains a primary goal for observational and theoretical astrophysics. The main scenario is that, driven by gravity, dark matter halos merge into progressively larger structures. The baryons in the dark matter haloes cool radiatively into material from which stars form. The number of stars that could be formed in this process far exceeds that which is observed, so a source of energy is needed to heat the cold gas, thereby reducing star formation. An important feedback mechanism is "AGN feedback" invoked by current cosmological galaxy formation models. This feedback is due to jets from active galactic nuclei (AGN) injecting large amounts of energy and momentum into the surroundings of their host galaxies. The outcome of the evolution processes is that galaxies can have very different shapes, masses, sizes, stellar populations, gas content, metallicities and star formation histories. Also, a huge variety of active nuclei are observed, ranging from weak activity at the centres of some galaxies, to explosive events in quasars that produce luminous emission over the entire spectrum

Operating at frequencies from 10 to 240 MHz, LOFAR is the world's premier low frequency radio telescope. The LOFAR Surveys Key Science Project (PI Röttgering) is conducting a series of unique low-frequency radio surveys with a range of depth, area and frequency. WEAVE is a multi-object spectrograph facility for the William Herschel Telescope (WHT) and will be commissioned at the end of 2020. One of its major science projects is to generate more than 10^6 spectra of LOFAR selected radio sources.

With these massive data sets (factor 100-1000 larger than before), we shall address the following questions relevant to AGN feedback:

1. How is the impact of AGN feedback related to the characteristics of the AGN, their host galaxies and environments?

2. How does the effect of AGN feedback change during the build-up of galaxies?

3. How does the impact of the feedback change when radio sources grow from kiloparsec to megaparsec scales?

4. What is the relative importance of the main drivers for the differences between radio AGN e.g. black hole mass, environment, accretion rate, stage of development, orientation? How does this change with redshift and how does this relate to the build-up of massive black holes since z~6?

Supervisor: Prof. H.J.A. Rottgering

Selection criteria: Research qualities and astronomical background

Applications:

To apply for this vacancy, please send an email to rottgering@strw.leidenuniv.nl. Please ensure that you upload the following additional documents quoting the project title:

- Curriculum vitae;
- Bachelor's and master's transcripts;
- (Draft of) MSc thesis.

Deadline: March 1st 2021

Project Title: Interpreting Galactic and Extra-galactic Molecular Observations Through Statistical Methods

Project description:

Molecules pervade the cooler, denser parts of the Universe. These gas components of galaxies, such as the Giant Molecular Clouds where stars form, contain a significant fraction of the non-stellar baryonic matter. Observing molecular gas is important for our understanding of how galaxies and stars form and evolve, since this denser, cooler gas is the only reservoir of matter for future star formation. Astronomers routinely observe the universe at sub-mm wavelengths at which many molecular species emit. Indeed, a wide variety of objects, from pre-stellar cores to extragalactic AGNs, are observable in the emission from hundreds of molecules.

A major motivation for these observations is the fact that unravelling the chemical and physical conditions that produce the emission allow us to understand the physical and energetic processes occurring in the observed gas. However, deriving physical properties from these observations involves complex chemical and radiative transfer models. Further, it is not always clear which molecules should be observed if one wishes to constrain specific physical parameters.

Throughout this PhD project the student will use statistical methods and machine learning to create tools that better facilitate this process. The student will use our chemical model and a popular radiative transfer model to produce datasets of molecules and their emission under different physical conditions, from those resembling the molecular clouds where stars form, to those in starburst galaxies and surrounding AGNs.

Combining these datasets with regression models and dimensionality reduction techniques, the student will produce recommendations for which molecular transitions should be observed by the astronomer who wishes to constrain a particular physical parameter. Further, they will develop emulators and invertible neural networks that allow observers to derive physical parameters from observations without running the complex chemical models that were used to produce our statistical models.

The models and initial methods that the student will develop are prepared so the project can start immediately. Once underway, the student will have ample opportunity to redirect the project according to their particular interests or ideas they develop.

Supervisor: Prof Serena Viti and Dr Jon Holdship

Selection criteria: An interest in statistics and ML techniques is desirable

Applications:

To apply for this vacancy, please send an email to ______. Please ensure that you upload the following additional documents quoting the project title:

- Curriculum vitae;
- Bachelor's and master's transcripts;
- (Draft of) MSc thesis.

Deadline: March 1st 2021

Project Title: Studying exoplanet's interior-atmosphere connection

Project description: Observations of exoplanet atmospheres are showing us the abundances of elements in dozens of exoplanets. Future instrumentation specially designed to observe exoplanet atmospheres (e.g. JWST, ARIEL), will provide even more data, moving us to an era of exoplanet characterisation.

In order to know what information are these abundances telling us about the formation history of the planet we need to know more about their interiors. Are the heavy elements homogeneously distributed (and then the observations in the atmospheres are showing also the mean abundances in the planet)? Or are they more abundant in the interior than in the atmosphere? Do these planets have a core? Understanding the interiors of giant planets is essential to know more about what we can learn from these observations.
In this context, the aim of this project is to study interiors of exoplanets analysing the influence of different parameters in their internal structure and evolution and determining which is the most likely structure of these planets and the link with their atmospheres. We will perform models in the context of the upcoming ARIEL (ESA) mission (the advisor is leader of the ARIEL chemistry working group), towards a better interpretation of the atmospheric data.

Supervisor: Yamila Miguel

Selection criteria: Students with background in physics astronomy or geophysics. Knowledge of programming.

Applications:
To apply for this vacancy, please send an email to ymiguel@strw.leidenuniv.nl. Please ensure that you upload the following additional documents quoting the project title:

- Curriculum vitae;
- Bachelor's and master's transcripts;
- (Draft of) MSc thesis.

Deadline: March 1st 2021

Project Title: **X-ray diagnostics of cold gas in AGNs and galaxies**

Project description:

We propose to study the key questions related to the evolution of galaxies and AGNs: how powerful is the feedback from supermassive black holes? How do AGN outflows interact with the surrounding matter? What happens when the gas of the galaxy cools in its center? We aim to probe the spectral features of charge exchange between hot and cold matter based on observed high-resolution X-ray and UV spectra of AGN and galaxies obtained with Hubble, XMM-Newton, Chandra, and possibly future XRISM (expected launch 2022).

Supervisors: prof. dr. Jelle Kaastra, dr. Liyi Gu, dr. Aurora Simionescu

Selection criteria: masters degree in astronomy; interests in astrophysics, spectroscopy, and atomic physics

Applications:
To apply for this vacancy, please send an email to j.kaastra@sron.nl. Please ensure that you upload the following additional documents quoting the project title:

- Curriculum vitae;
- Bachelor's and master's transcripts;
- (Draft of) MSc thesis.

Deadline: March 1st 2021

Project Title: **Advanced atomic data and modeling for X-ray spectroscopy**

Project description:

We aim to improve our knowledge of atomic transitions and models for cosmic X-ray sources to the level required by future X-ray instruments: XRISM (expected launch 2022) and Athena (2031). The advanced atomic calculations and modeling are essential for fully exploiting the data obtained with these instruments. The new improvements will be implemented in the SRON code SPEX, and will be applied to the high resolution X-ray spectra of current and future X-ray instruments.

Supervisors: prof. dr. Jelle Kaastra, dr. Liyi Gu

Selection criteria: masters degree in astrophysics or atomic physics; interests in spectroscopy

Applications:
To apply for this vacancy, please send an email to j.kaastra@sron.nl. Please ensure that you upload the following additional documents quoting the project title:

- Curriculum vitae;
- Bachelor's and master's transcripts;
- (Draft of) MSc thesis.

Deadline: March 1st 2021