– PhD Position at LAM –

Characterization of young giant exoplanets: from low to high spectral resolution

Location:	Laboratoire d'Astrophysique de Marseille (LAM; https://www.lam.fr/)
Funding:	ERC HiRISE (PI Arthur Vigan, grant agreement #757561)
Duration:	3 years
Starting date:	October 2018 (flexible)
Deadline:	31 May 2018
Supervisor:	Arthur Vigan (CNRS/LAM)
Co-supervisor:	Possible co-supervision with ESO Chile (Pedro Figueira)
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Context

The atmospheric composition of giant gaseous exoplanets provides essential markers of their most fundamental properties, such as their formation mechanism, formation location in the protoplanetary disk or internal structure. The new-generation exoplanet imagers on 8-meter telescopes equipped with extreme adaptive optics, VLT/SPHERE and Gemini/GPI, have been designed to detect very faint planetary companions (contrast ratio > 10^5) at small angular separations (<0.5") in the near-infrared, but they only provide very low spectral resolutions (R<100) for their characterization. Their measurements can be used to constrain the basic atmospheric properties of the planets but for a leap in the understanding of giant exoplanets, the spectral resolution needs to be increase by 2 to 3 orders of magnitude.

Since a few years, high-dispersion spectroscopy (HRS) at resolutions up to R=10^5 coupled with high-contrast imaging (HCI) appears as one of the most promising pathways for the detection of exoplanets. The potential of HRS ranges from molecules identification, improved orbital constraints, atmospheric variability or even Doppler imaging of the photosphere. However, there are still many questions regarding the potential of this technique for the quantitative estimation of physical parameters, and more generally for detailed atmospheric characterization of directly imaged companions.

The goal of ERC project HiRISE is to bring high-spectral resolution to one of the best exoplanet hunters available today, SPHERE at the Very Large Telescope. We will implement a prototype fibre coupling with CRIRES+, the high-dispersion near-infrared spectrograph for the VLT, which we will use for the characterization of a sample of know young giant exoplanets. The project will explore the key instrumental and astrophysical aspects of the coupling using theory, instrumental and astrophysical simulations, modelling. Data acquired on-sky with the prototype will be used to answer cutting-edge astrophysical questions on young exoplanets.

More information on HiRISE: http://astro.vigan.fr/hirise.html

PhD project

The proposed PhD project fits within the preparation of HiRISE, and more generally of future instrumentation that will provide HCI and HRS capabilities.

The first part of the PhD project will focus on revisiting spectral characterisation at low-resolution based on VLT/SPHERE results obtained either with the integral field spectrograph (IFS) or the long-slit spectroscopy mode (IRDIS/LSS). This essential step will enable the student to identify the limitations of current high-contrast imaging instruments. The work will be based on data acquired in the context of the SHINE large-scale survey co-directed by LAM, as well as additional data acquired with SPHERE in open time.

The second phase will be more exploratory. It will focus on preparing the characterisation of companions at high-spectral resolution with the HiRISE prototype. In anticipation of real data from HiRISE, the student will develop tools and techniques based on HRS data coming from other instruments like CFHT/SPIRou, VLT/CRIRES+ or ESO/NIRPS.

Finally, a more prospective phase will be the exploration of the exoplanet detection capabilities with ELT/HARMONI, an instrument partly developed at LAM in the instrumentation group. HARMONI will provide an IFS with resolutions from R=3 000 to 20 000 in the near-infrared on the European extremely large telescope. The expected levels of contrast and spatial resolution of this instrument, combined with HRS techniques, could potentially enable the redetection and characterisation of exoplanets provided by the on-going ESA/Gaia mission. With independently determined masses, such exoplanets would provide unique calibrators for exoplanet formation and evolution models.

Over the course of the PhD, the student will work in close collaboration with the HiRISE team (6 people at LAM, plus external collaborators). The PhD will be done at LAM in the planetary science group (GSP). The successful applicant will benefit from the rich local scientific environment, working with experts in exoplanets and related instrumentation.

(S)He will also have the opportunity to disseminate the results of her/his research in the international community and reinforce the collaboration between the national and international institutions involved in the project. Existing collaborations include IPAG in Grenoble (Mickaël Bonnefoy), ESO in Santiago de Chile (Pedro Figueira), and the International Franco-Chilean Laboratory of Astronomy in Santiago de Chile (Gaël Chauvin). Long duration stays in one of these institutes could be considered over the course of the project.

Application

Applicants should send a PDF file by e-mail containing:

- A 1-page letter of motivation;
- A curriculum vitae;
- A copy of the highest-level diploma;
- Marks and ranking at the Master's level

to Arthur Vigan (arthur.vigan@lam.fr). Please also arrange for 2 letters of recommendation to be e-mailed directly.

Applications sent before 1 June 2018 will receive full consideration. Past this date applications will be considered upon availability of the position. LAM and CNRS are actively committed to equal opportunity in employment.

Bibliography

- Snellen et al., 2015, A&A, 576, A59: https://arxiv.org/abs/1503.01136
- Wang et al., 2017, AJ, 153, 183: https://arxiv.org/abs/1703.00582
- Mawet et al., 2017, ApJ, 838, 92: https://arxiv.org/abs/1703.00583
- Hoeijmakers et al., 2018, A&A: https://arxiv.org/abs/1802.09721