

Thesis subject

Name of the laboratory: LAM

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Subject's title: High-precision radial-velocity for exoplanet characterisation : follow-up of the transiting candidates from the North (SOPHIE) to the South (NIRPS/HARPS)

Subject description:

Among the 3800 planets detected (and many more candidates), transiting planets that are characterised accurately in mass and in radius, hence giving access to their mean bulk composition, have a considerable impact. Moreover, transiting planets offer a unique opportunity to gather information about the composition and temperature of their atmospheres, as well as the presence of molecular species, including biosignature gases or surface features.

The TESS mission from NASA was launched in April 2018 and delivers thousands of transiting candidates. The mission is performing a nearly full-sky search for small planets transiting relatively bright stars. The southern sky is observed since August 2018, and the northern sky will be observed starting in mid-2019 and will last one year. The mission may be extended for several years and the data is directly public.

SOPHIE is a high-precision radial-velocity (RV) spectrograph in the visible mounted on the 1.93m telescope at OHP (France) since 2006. After several instrumental improvements, SOPHIE is now able to detect Super-Earth and Neptune planets with an accuracy of less than 2m/s. The number of RV facilities across the world that have already proven to reach a precision at the level of 1-2 m/s is still very low. Among them, SOPHIE is the only northern instrument dedicated to exoplanet search with more than 250 nights per year allocated. The Consortium SOPHIE leads since 2011 a large program to search for low-mass objects around solar-type stars. More than an hundred of stars were measured, and exoplanets have been discovered (e.g. Bouchy et al 2013, Courcol et al 2015, Hobson et al. 2018, Diaz et al. in prep., Hobson et al. subm.).

NIRPS is high-resolution high-accuracy spectrometer in the nIR to be mounted on the 3.6m-telescope at La Silla, ESO in fall 2019. Once mounted, NIRPS and HARPS

are bound to become a single powerful high-resolution, high-fidelity spectrograph covering from 0.4 to 1.8 micron, allowing precise simultaneous radial velocity measurements in the NIR at the 1-m/s level for M dwarfs and in the VIS at a level of 80-cm/s or better for G & K dwarfs. Transiting planets around M dwarfs that will be one of the three scientific projects of NIRPS are primary targets to receive a lot of observing time with JWST for atmospheric studies. Being part of the NIRPS scientific team, a program of 500 nights over 5 years has been granted to the constructing team. A third of them will be dedicated to characterise the transiting candidates.

The PhD student will be part of the SOPHIE Consortium and will be part of the TESS follow-up programs. The student will be part of the high-precision programs with SOPHIE (PI of this program is the PhD advisor). This program gets around 60 nights per semester. The student will also be deeply involved in the TESS follow-up programs that will begin in fall 2019. At the same time, the student will be also involved in the TESS follow-up with the NIRPS/HARPS instrument for which the PhD advisor is part of scientific team. The student will analyse the data gathered with these instruments.

The Consortium SOPHIE is an European group of ~20 researchers (3 institutes in France, one in Geneva, Switzerland, and one in Porto, Portugal). I.B. is the PI of the SOPHIE high-precision programs, and she is part of the NIRPS's scientific team. The exoplanet group at LAM is also strongly involved in several other projects: NIRPS, SPIRou, SPHERE, CHEOPS, TESS and PLATO.

Bibliography:

SOPHIE Instrument description :
<http://www.obs-hp.fr/guide/sophie/sophie-eng.shtml>

SOPHIE Consortium Presentation

- Bouchy, F., Hebrard, Udry, Delfoss, Boisse et al. 2009 A&A, 505, 853 : The SOPHIE search for northern extrasolar planets . I. A companion around HD 16760 with mass close to the planet/brown-dwarf transition

SOPHIE high-precision program results :

- Courcol, B., Bouchy, F., Pepe, et al. 2015, A&A, 581, 38 :
The SOPHIE search for northern extrasolar planets. VII. A warm Neptune orbiting HD164595

- Hobson, M., Diaz, R., Delfosse, X. accepted by A&A, arXiv:1806.10958 : The SOPHIE search for northern extrasolar planets. XIII. Two planets around M-dwarfs

Gl617 and Gl96

NIRPS instrument and science description :

Near-InfraRed Planet Searcher to Join HARPS on the ESO 3.6-metre Telescope

Bouchy, Doyon, Artigau, Melo, Hernandez et al. 2017, Mnsgr, 169, 21

<http://cdsads.u-strasbg.fr/abs/2017Mnsgr.169...21B>

TESS website :

<https://www.nasa.gov/tess-transiting-exoplanet-survey-satellite>