The longest baseline: 30 years of spectroscopic measurements for exoplanets with ELODIE and SOPHIE

ELODIE is the spectrograph mounted at the 1.93m telescope at the Haute-Provence Observatory (OHP) that allows the detection of the first exoplanet around a solar-type star in 1995. This instrument observed between 1994 and 2006. SOPHIE is the high-precision spectrograph that replaced ELODIE in 2006. Since a major instrumental improvements in 2011, it daily delivers 1m/s accuracy on stellar radial velocities. These radial velocities are used to search for exoplanets around nearby stars.

The unique dataset obtained at OHP (several thousands of different stars observed with more than 300 nights per year), the longest radial-velocity baseline in the world still have many treasury to reveal. Among them, we can derive exoplanet occurrence rates, such as the frequency of stars hosting planets or the average number of planets per star. This allows us to directly constrain planet formation and migration scenarios. We can also compare the physical properties of the various exoplanet populations, such as giant planet within and beyond the water ice line (where they are expected to be formed), their eccentricity distribution with is a tracer of their dynamical history, and explore the relation between inner small planets and outer massive planets. Thanks to the 30-year baseline, the OHP dataset can probe giant planets up to the orbit of Saturn, hence filling the gap with the planets that are directly imaged at very long orbital distances. Moreover, in December 2026 a new release of the GAIA catalog is expected to include thousands of Jupiter-like candidates. These astrometric data will be complementary to the OHP dataset to confirm the planets and to characterize the entire systems.

The objective of this thesis will be twofold: improving the data reduction analysis in order to get the best accuracy on the longest baseline [c'est pas déjà le boulot de Loula ?], and a complete, statistical analysis of the ELODIE+SOPHIE data to derive robust occurence rate on giant planets occurence, [analysis of the impact of the stellar parameters, and contribute to the GAIA follow up]. The PhD will be also fully involved in different programs search and characterization for SOPHIE.

This PhD subject is included in a collaborative project obtained with IPAG at Grenoble, IAP at Paris and IRAP at Toulouse. The PhD project will be at LAM or OHP with visits at IAP and IPAG.

The PhD advisor, Jean-Luc Beuzit, is part of the LAM and the PI of the SPHERE instrument and of the SPHERE+ project. He is an internationally recognize

specialist of directly imaged exoplanets. …. The co-PhD advisor, Isabelle BOISSE is part of the LAM and currently located at OHP. She is responsible or co-investigator of several SOPHIE programs and in strong collaboration with an European group of ~20 researchers (3 institutes in France, one in Geneva, Switzerland, one in Porto, Portugal, and one in Birmingham, UK). She is also strongly involved in the SPIRou programs and she is the French representative for the construction of the ANDES spectrograph for the ELT. The exoplanet group at LAM is also involved in several other projects: SPHERE, CHEOPS, TESS, Roman, PLATO, ARIEL and HARMONI.