Giant planets survey with SOPHIE at OHP

Shweta Dalal[1], Guillaume Hébrard[1,2], SOPHIE Team
[1.] *Institut d'Astrophysique de Paris, UMR 7095 CNRS, Sorbonne Université, 98bis boulevard Arago, 75014 Paris, France*
[2.] *Observatoire de Haute-Provence, CNRS, Université d'Aix-Marseille, 04870 Saint-Michel-l'Observatoire, France*

Abstract

SOPHIE spectrograph was installed at Observatoire de Haute-Provence (OHP) in 2006 in particular to perform various radial velocity surveys to study exoplanets (Bouchy *et al.* 2009). The goal of one of the SOPHIE surveys for giant exoplanets, is to detect new objects and to improve the statistics on giant extrasolar planets. The current version of the catalog includes stars at a distance < 60 pc and B − V between 0.35 and 1. The statistical survey of these giant planets allows us to distinguish between populations like super-Earths, giant planets, and brown dwarfs and also to obtain correlation between the different parameters of these exoplanets and their host stars. It gives us an opportunity to follow-up multi-planet systems and study their characteristics. Thus, detecting and characterizing new giant planets will not only allow us to explore the diversity of planetary systems but also put some constraints on the models of giant planet formation and evolution.

Giant Planet Survey

The main objective of the this program is to search for the giant planets orbiting with different periods around the nearby bright stars. It will help in characterizing new giant planets and improve the statistics of the parameters of the detected exoplanets. Another objective of the giant planet survey is to identify the stars that host low-mass planets which can be observed by SOPHIE for high precision radial velocity surveys.

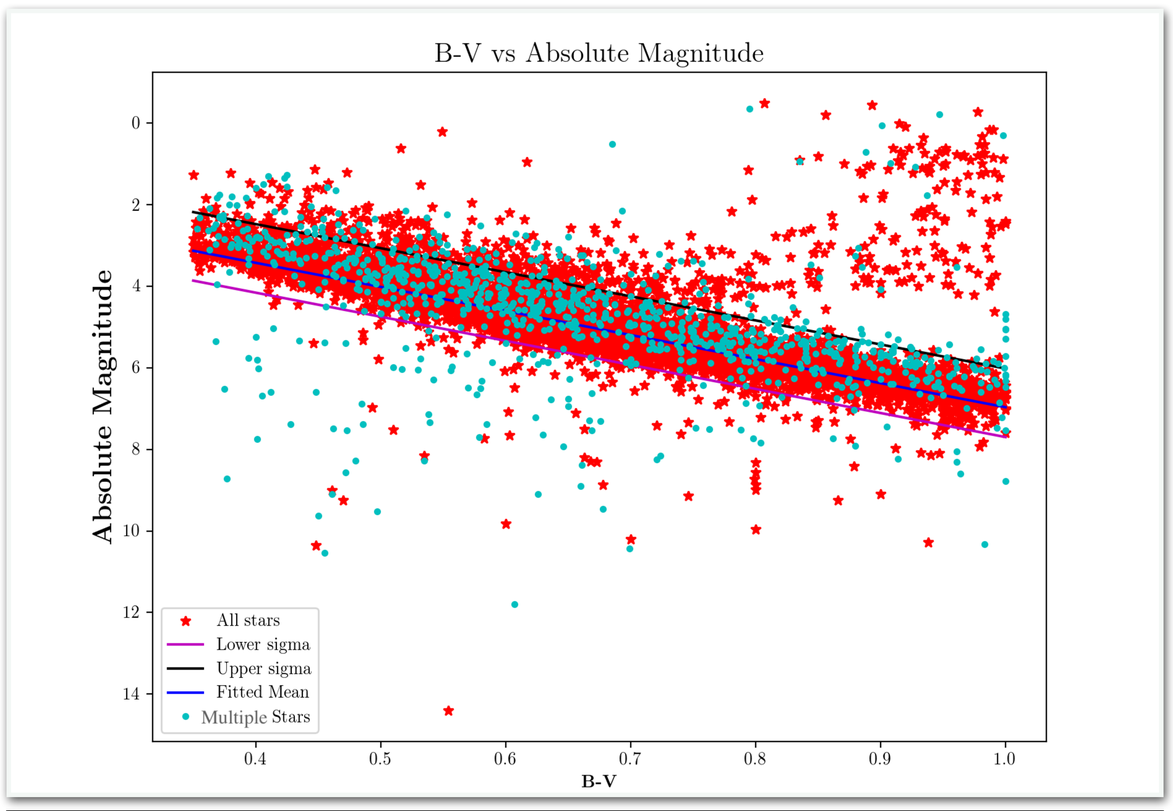

Fig.2. shows the stars listed in the giant planet catalog. The sample of stars selected for study is delimited by straight lines representing upper and lower sigma.

The giant planet catalog will contain the observed and derived parameters of detected giant planets. Such statistical survey will help in understanding and establishing the relationship between different parameters of these exoplanets and their host stars. This catalog will also identify the stars that hosts multi-planet systems.

Why study Giant Planets?

- Since the detection of first exoplanet, 51 Peg b, approximately 3700 exoplanets were detected using different techniques.
- Most of the giant planets orbit close to their host stars i.e. within semi-major axis of 0.1 AU.
- These close-in giant planets were not predicted by the classical theories of the planet formation. Different processes of orbital migration such as migration within disc, planet-planet scattering and kozai migration can explain these close-in planets.
- Characterizing and studying the giant planets will not only help in understanding the reason for their orbital migration but will also put some constraints on their origin.

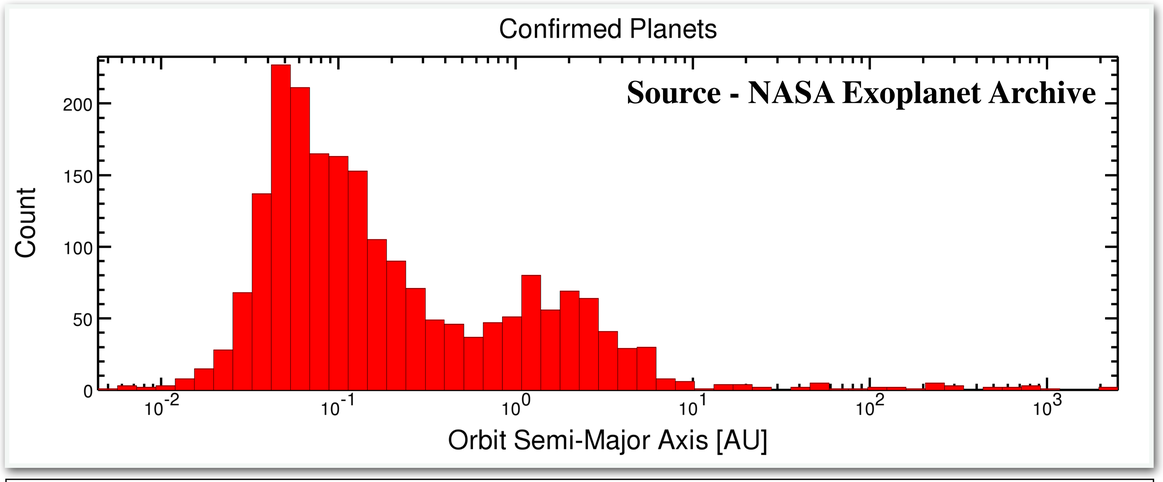

Fig.1. Distribution of the semi-major axis of planets orbiting their host stars.

Giant Planet Catalog

The catalog is created from Hipparcos catalog. It includes stars up to a distance of 60 pc and B-V in between 0.35 and 1.

All multiple stars are excluded.

↓

A skew-normal distribution is fitted along absolute magnitude in order to determine the value of upper and lower sigma.

↓

Upper and lower sigma are twice the HWHM (Half Width at Half Maximum) of fitted skew normal distribution.

↓

The sample of stars selected for the study is delimited by two straight lines representing upper and lower sigma.

↓

Approximately 4700 stars are selected to perform the statistical survey of giant planetary systems.

Giant planets detected under the survey

In this section, we present the study of few giant planetary systems that were detected using SOPHIE. Boisse *et al.* (2010) detected an exoplanet of mass 0.77 M_J around HD109246 with period of 68.2 days. Hébrard *et al.* (2016) reported a total of 12 giant exoplanets which includes six new single planets and two multi-planet systems around HIP65407 (2 planets) and HD141399 (4 planets) using SOPHIE. The range of mass of the detected planets is 0.428 M_J to 3.76 M_J and their period is 2.1974 days to 3370 days. Recently, Rey *et al.* (2017) reported the detection of three new planets orbiting the solar-type stars HD17674, HD29021, and HD42012 with masses between 0.87 M_J and 2.4 M_J and periods from 623.8 days to 1362.3 days.

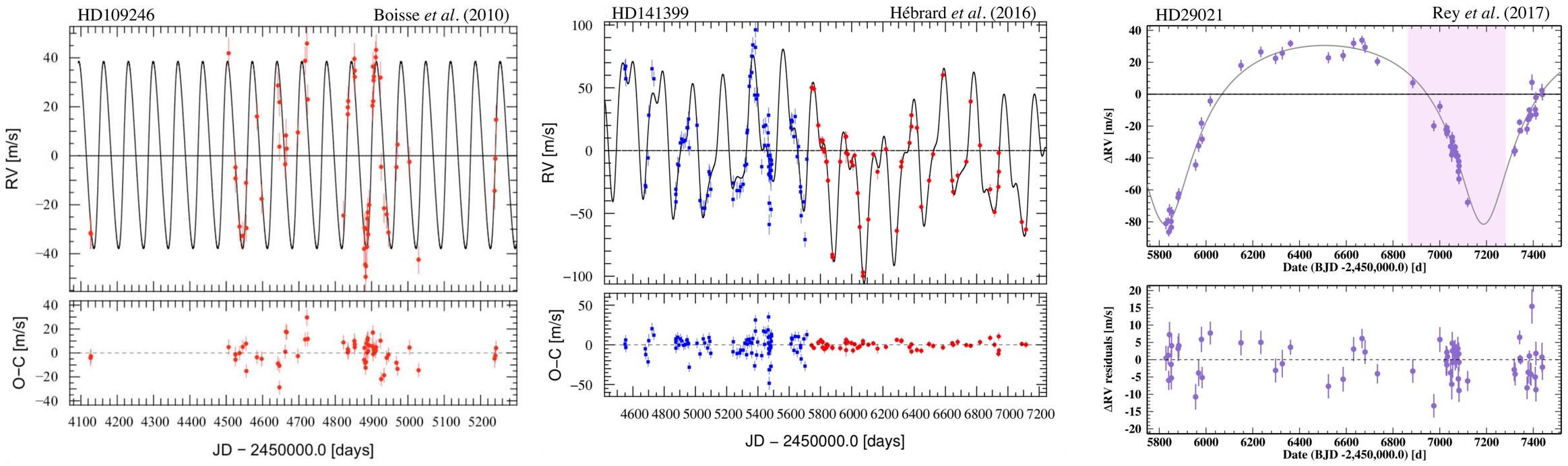

Fig. 3. SOPHIE radial velocity measurements and corresponding Keplerian fits of the three stars as a function of time. (In the second plot, values before and after June 2011 upgrade are plotted in blue and red respectively.)

Summary and Future Work

- The radial velocity survey, will help in finding the population of giant exoplanets with longer orbital period and multi-planet systems.
- It will also identify stars hosting low-mass planets that can be observed under high precision radial velocity surveys.
- We will also perform a statistical survey to obtain correlation between the different parameters of these exoplanets and their host stars.
- This statistical survey of such planetary systems will allow us to distinguish between population of exoplanets.
- It can also put some constraints on the theories of planets formation and evolution.

References:

1. Bouchy, F., Hébrard, G., Udry, S., *et al.* 2009, A&A, 505, 853
2. Boisse, I., Eggenberger, A., Santos, N. C., *et al.* 2010, A&A, 523, A88
3. Hébrard, G., Arnold, L., Forveille, T., *et al.* 2016, A&A, 588, A14
4. Rey, J., Hébrard, G., Bouchy, F., *et al.* 2017, A&A, 601, A9