Stellar "noise" characterization for the detection of terrestrial planets

Ph-D Thesis Committee - 2014

TAS responsible:	Organization:	Date :
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Objective:

The objective is to characterize the stellar "noise" for the detection of planets. The principle is based on simulations of the stellar surfaces and statistical characterization of this noise. The Co-managers would be L.Bigot and D. Mary from Lagrange Laboratory (Observatoire Côte d'azur - France). This work is in connection with the preparation of the future space mission PLATO of ESA, , which has been recently selected as mission M3.

State of the art - proposed Innovation:

Since the first detection of an exoplanet in orbit around a star in 1995, the number of exoplanets did not stop growing to reach around one thousand objects. The most promising detection method , using the radial speed, consists in measuring by spectroscopy the velocity of the star induced by the planet. The measure is linked to the size of the planet and the first planets detected were huge, similar to Jupiter, and induce velocities of the star of tenth of m/s which are easy to detect. The improvements of spectrographs, in particular in term of stability, allows to detect smaller and smaller planets and since 2 or 3 years it is possible to detect planets of land masses. However, this detection remains extremely difficult because the generated velocity represents only some cm/s. The measure is affected by other effects; it is necessary to understand and modelize them. i.e. the hydrodynamic movements generated by the star itself may mask the attraction of the planet.

In this context, the purpose of this thesis is to characterize carefully the statistics of this stellar "noise" by means of realistic 3D hydrodynamics simulations of the stellar surfaces; that has never been done before. Simulations have been developed by the Thesis directors whcih are at the state of the art. The detection techniques requiered for the thesis will use recent innovations in theory of the decision to deal with weak signals diluted in massive data flow. This work which has never been done before and is fully innovative. The student will have at his/her disposal results of simulations which he can use to start effectively its work. The objective of the detection proposed in this thesis is a hot topic in astrophysics as we are always seaking for the first exo-Earth compatible with human life; that is which could accommodate some liquid water. In this objective several ground and space instruments will be developped in the next decades, such as spectrographs ESPRESSO (VLT / ESO), HARMACOPOEIA(CODEX) (ELT, ESO) and the space mission recently selected PLATO (CNES / ESA). This thesis will bring a new and relevant perspective on the characterization of the performances of the instruments.

Laboratory:	Experience
France / Observatoire Côte Azur / Lab. Lagrange	

Candidate:

TBD

Financial partner:	**Any Comment** (1st contact , 2nd partner ? …)
France / Grant from Region Provence- Alpes - Côte Azur (PACA)	

Ph-D Thesis: Activités - Etapes

Two steps:

First understand and characterize statistically the signal disturbation due to the fluctuations of the brightness in simulations of stellar surfaces, it is generated by turbulent convection and oscillations . The study will focus on some stars known to host exo -Earths that can be easily detected.

The second step will be to inject signals from planets of different sizes in the curves of light for the stars under study ; characterize their detection in different configurations of the parasitic signal related to the hydrodynamic motion of the star.

The student will benefit from the complementary expertise of its two co- supervisors : stellar physics and signal processing. Tools and techniques are at the state of the art of research in each area. The experience gained through this thesis will be valuable for the future career of the candidate; he (she) may also benefit from interactions with many teams in planetology and signal processing within the laboratory.