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Radial velocity follow-up of PLATO transiting candidates

F. Bouchy (1,2), S. Udry (3), C. Moutou (4), X. Bonfils (5), E.W. Guenther (6), R. Diaz (1,2), T. Forveille (5), G. Hébrard (1,2), F. Pepe (3), A. Santerne (4), D. Ségransan (3)
(1) Institut d'Astrophysique de Paris, UMR7095 CNRS, Université Pierre & Marie Curie, 98bis Bd Arago, 75014 Paris, France
(2) Observatoire de Haute-Provence, CNRS/OAMP, 04870 St Michel l'Observatoire, France
(3) Observatoire de Genève, Université de Genève, 51 Ch. des Maillettes, 1290 Sauverny, Switzerland
(4) Laboratoire d'Astrophysique de Marseille, 38 rue Frédéric Joliot-Curie, 13388 Marseille cedex 13, France
(5) Institut de Planétologie et d'Astrophysique de Grenoble, Université J. Fourier, CNRS, 38041 Grenoble cedex 9, France
(6) Thuringer Landessternwarte, Sternwarte 5, Tautenburg 5, D-07778 Tautenburg, Germany

Abstract

PLATO is a proposed ESA mission devoted to better understand the properties of exoplanetary systems. As such it will detect and characterise exoplanets using their transit signature in front of a large sample of bright stars and simultaneously measuring the seismic oscillations of the parent star of these exoplanets. An intensive effort of ground-based observations are required to complement the observations made by PLATO to allow for further exoplanetary characterization. Here we present some elements about the strategy and organization of the ground-based radial velocity follow-up of PLATO transiting candidates to establish the nature of the transit events and to characterize their masses from earth-like planets to brown-dwarfs.

1. The PLATO mission

The PLATO (PLAnetary Transits and Oscillations of stars) space mission will be devoted to collect in visible light, long, uninterrupted, ultra-high precision photometric light-curves of a sample of at least 180 000 relatively bright stars (mv < 11), in order to detect planetary transits and characterize the main hosting star parameters by asteroseismology.

The main goals of the PLATO core program is : 1) to build a statistically significant sample of Earth-size planets orbiting main sequence stars with spectral types ranging from F to M in their habitable zones. 2) to determine, through asteroseismology, the radius and mass of the parent star with an accuracy of 1%, and derive the age of the systems to an accuracy better than 10%. 3) to allow the selection of a sample of bright and nearby systems for further studies with ambitious future facilities.

The PLATO reference payload consists of 34 refractive cameras (see Fig.1) each with a FoV with a diameter of 37^o. The 6-years nominal duration of the scientific exploitation phase consists of three parts: two long-duration observations (of 3 & 2 years respectively), each focusing on a particular part of the sky with a high density of F, G and K dwarf stars, plus a one year long step-and-stare phase where a small number of selected fields will be monitored for a few months each.

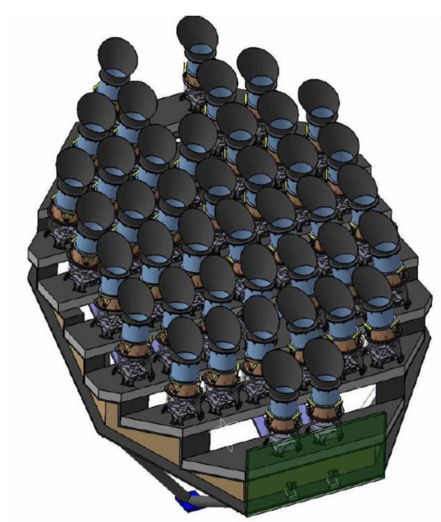

Figure 1: Instrumental PLATO design

2. Main goals of radial velocity follow-up

The main goals of the ground-based follow-up of PLATO transit candidates are to establish the nature of the transit events and to characterize the mass of real transiting companions from earth-like planets to brown-dwarfs.

The PLATO candidates will have to be cleaned as much as possible from false positives by diagnostics applied directly on the high-precision light curves as well as by ground-based ON-OFF photometry to check for transits on the neighboring stars included in the PLATO photometric windows.

The multi-step approach going from moderate- to high-precision instruments already successfully used in most of the on-going surveys (like Super-Wasp, CoRoT and Kepler) will also be apply to PLATO candidates. The Table 1 list the different classes of RV precision facilities and their associated role in the PLATO follow-up.

Table 1: Radial velocity precision and their associated functions in the follow-up.

RV precision	Functions
25 - 50 $\mathrm{m\,s^{-1}}$	Binaries, Brown-dwarfs, Massive HJs
5 - 10 $\mathrm{m\,s^{-1}}$	Jupiters, Hot Saturns, Blends
1 - 2 $\mathrm{m\,s^{-1}}$	Neptunes, Hot Super-Earths, Blends
<40 $\mathrm{cm\,s^{-1}}$	Super-Earth, Earth, Blends

All the existing and in-development RV facilities (see Fig.2) which will be in operation during the PLATO mission (2019-2027) will be used for the huge expected effort required for follow-up of thousands transiting candidates.

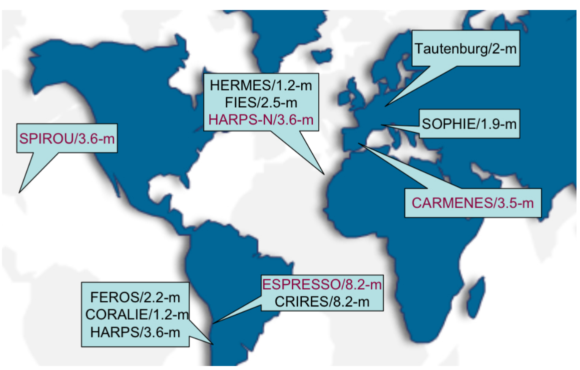

Figure 2: Existing and in-developement radial velocity facilities for PLATO follow-up.

RV facilities should include a maintained telescope and spectrograph, a significant dedicated number of effective clear night per years for the PLATO follow-up, an identified technical and scientific team in charge of the instrument and in charge of the observations, a full data reduction software providing in real time the reduced spectra, RV velocity in the Barycentric frame, RV uncertainties, and bisector spans. Facilities will not be ranked as function of the telescope diameter but as a fonction of the RV uncertainties effectively obtained for a solar-type star of magnitude mv=11 in 1-h exposure.

The RV follow-up will also provide as by-product the spectroscopic parameters of the central stars, the stellar activity indicators, the spin-orbit angle measurements (through Rossiter-MacLaughin effect), and the possibility to detect additional non-transiting companions in the system.