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SOPHIE and HARPS-N spectroscopy of *Kepler* transit candidates

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Abstract

In this presentation, we present our results based on SOPHIE and HARPS-N follow-up observation of *Kepler* transiting candidates. Our large program led us to characterized 17 planets and brown dwarfs up-to-now, for which some of them will be announced during this presentation. Our program also permit to measure, for the first time, the false-positive rate of the *Kepler* mission, in the range of close-in giant candidates.

1. Introduction

Launched in 2009, the *Kepler* space telescope has discovered thousands of new transiting candidates, including Earth-size planets in the habitable zone of their host star [7]. These transiting candidates can be either explained by a transiting planet or by various configuration of astrophysical false positives [12]. These false positives involve eclipsing binaries in the background or gravitationally bound with the target star [8]. Diluted transit of giant planets are also contributing significantly to the false positive probability of Neptune-size and Earth-size candidates [12]. To establish the planetary nature of a transiting candidate, one of the technique consists in performing a radial velocity follow-up to establish the presence of a possible contaminating system, if any and to characterize the transiting object's mass [4].

We started in July 2010, one month after the first *Kepler* transiting candidate release [6], a large-program of radial velocity follow-up observations with the SOPHIE spectrograph, mounted at the 1.93-m telescope of Haute-Provence Observatory. This program is now completed by observations with the new HARPS-N spectrograph, commissioned in mid-2012 and mounted at the 3.6-m TNG telescope in La Palma. We present our radial velocity follow-up program and highlight our latest discoveries and results with newly established planets.

2. Characterization of *Kepler* transiting planet and brown dwarfs

Thanks to SOPHIE and HARPS-N observations, we characterized up to 17 transiting planets and brown dwarfs among the list of *Kepler* candidates [2]. These sub-stellar objects are listed in Table 1.

In addition to regular planets, we identified and fully characterized five new transiting companion with mass at the limit between massive planets and very low-mass stars (see Fig. 1). These members of the brown dwarf desert permit us to better understand the physical proprieties of such unique objects and to constrain their formation and evolution models.

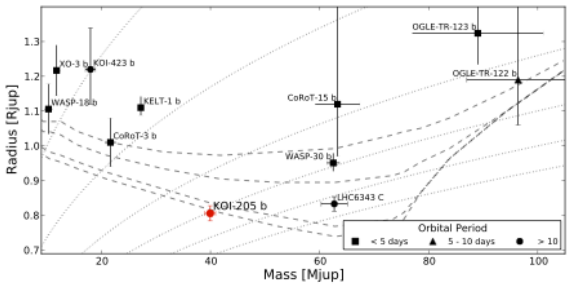

Figure 1: Mass – Radius diagram of transiting brown dwarfs characterized so far [11].

Table 1: List of *Kepler* planets and brown dwarfs characterized thanks to SOPHIE or HARPS-N data.

KOI ID	Kepler ID	Period [d]	Mass [$M_{\rm jup}$]	Radius [$R_{\rm jup}$]	Ref.
KOI-13	Kepler-13	1.76	$<$14.8	2.2	[19]
KOI-135	Kepler-43	3.02	3.23	1.20	[3]
KOI-196	Kepler-41	1.85	0.55	0.89	[18]
KOI-200	Kepler-74	7.34	0.68	1.32	[13]
KOI-203	Kepler-17	1.49	2.47	1.33	[3]
KOI-204	Kepler-44	3.25	1.02	1.24	[3]
KOI-205	—	11.72	39.9	0.81	[11]
KOI-423	Kepler-39	21.09	18.0	1.22	[5]
KOI-428	Kepler-40	6.87	2.2	1.17	[17]
KOI-889	Kepler-75	8.88	9.9	1.03	[13]
KOI-XXX	—	1.7	XXX	0.9	[9]
KOI-XXX	—	5.3	XXX	0.7	[1]
KOI-XXX	—	12.9	XXX	0.7	[1]
KOI-XXX	—	8.6	XXX	0.6	[1]
KOI-XXX	—	167	XXX	0.6	[16]
KOI-XXX	—	30	XXX	0.9	[10]
KOI-XXX	—	52	XXX	1	[10]

3. False-positive rate of *Kepler* close-in giant candidates

By observing a complete sample of *Kepler* candidates with an orbital period of less than 25 days, a transit depth greater than 0.4% and host star brighter than magnitude $K_p = 14.7$, we measured, for the first time, the false-positive rate for this range of *Kepler* candidates (see Fig. 2) . Our value of 35% [20] derived from complementary observations disagrees with other values, based on theoretical studies [15] that were used to study the statistical proprieties of extrasolar planets, based on the *Kepler* list of candidates [14].

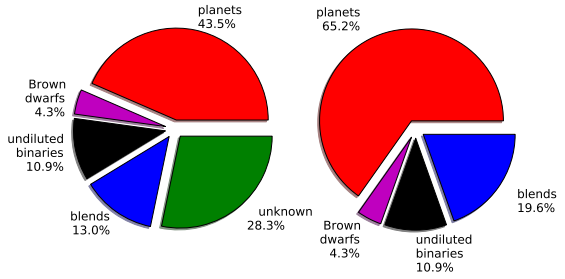

Figure 2: Pie chart of the nature of *Kepler* close-in giant candidates, as determined thanks to SOPHIE observations [20].

Acknowledgements

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