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Press release from Laboratoire d'Astrophysique de
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(Institut Pythéas, Aix - Marseille University & CNRS)

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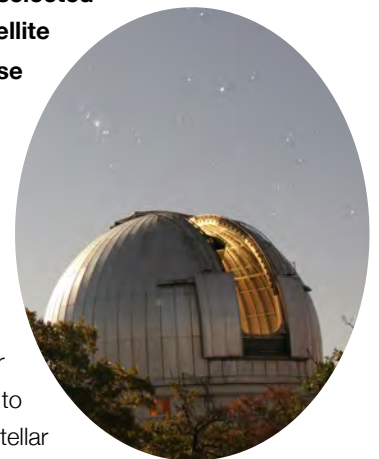
**At the Observatoire de Haute-Provence, astronomers
unveil the true nature of the planet candidates detected
by the *Kepler* satellite**

Using the SOPHIE¹ spectrograph installed at the 1.93m telescope of the Observatoire de Haute-Provence (southern France), a team led by scientists from Laboratoire d'Astrophysique de Marseille has identified ten new planets and five new brown dwarfs and low-mass stars among a selected sample of planet candidates detected by the US satellite *Kepler*². They were also able to estimate the rate of false giant planets hidden in the data of the NASA satellite.

The NASA satellite *Kepler* identified more than 2300 planet candidates by observing the tiny dips in the luminosity of a star produced when a planet crosses its disk, as during the Venus transit in front of the Sun last June 6th. This luminosity drop, called a planetary transit, can be mimicked by various astrophysical systems involving several stars. When the *Kepler* satellite identifies planet-like transits, it is therefore necessary to determine whether they are due to exoplanets or to mimicking stellar systems. One of the possible methods to establish the origin of the signal is to measure the radial velocity variation of these candidates caused by a companion.

« We used the SOPHIE spectrograph at Observatoire de Haute-Provence during several campaigns. SOPHIE is indeed one of the most performant instruments in the world for measuring the radial velocities of stars. In this way, we were able to elucidate the nature of the planetary candidates discovered by *Kepler*, and to measure the mass of the transiting objects, » explains Alexandre Santerne, PhD student at the Laboratoire d'Astrophysique de Marseille.

Their observations have permitted the team of astronomers³ to discover celestial objects of very diverse nature:



Night view of the 1.93m dome at Observatoire de Haute-Provence



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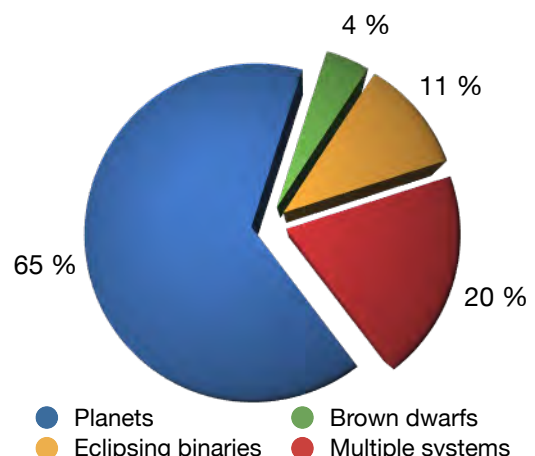
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★ **Hot jupiters** : ten new planets with masses comparable to Jupiter and orbiting very close to their stars were found. They are therefore extremely hot, and a year on such planet lasts only a few days. The hottest of the ten planets identified by SOPHIE, KOI-196 b (Kepler-41 b), could have a temperature as high as 1500°C. The planet KOI-206 b shows an elliptic orbit albeit its very short orbital period. Finally, planet KOI-428 b (Kepler-40 b) orbits a dying star, twice as large as the Sun! These planets complement the sample of planets already announced by the *Kepler* team.

★ **Brown dwarfs and very low-mass stars** : brown dwarfs have radii similar to that of Jupiter but are over 20 times more massive. They are the keystone between stars and planets, and they are extremely rare: only a handful such objects were known so far, among which two had been discovered in Marseille using the CNES satellite *CoRoT*⁴. The team in Marseille measured the mass and radius of five new brown dwarfs and very low-mass stars with masses in between 18 and about 120 times Jupiter's mass.

★ **Binary and tertiary stellar systems** : in such systems, all objects have a mass larger than about 100 times the mass of Jupiter (or 10% the Sun mass) but they cannot be distinguished from planets from *Kepler* data alone. With the SOPHIE spectrograph, the astronomers were able to identify these impostors. An independent american study had estimated that only 5% among the 2300 planetary candidates were impostors. However, the study led by researchers from Laboratoire d'Astrophysique de Marseille indicates a larger proportion of impostors: close to 35% for impostors mimicking giant planets. «*This fact should be taken into account in statistical investigations performed from the sample of Kepler candidates,*» specifies Alexandre Santerne. However, «*this rate of impostors does not necessarily apply to smaller planet candidates (about 90% of Kepler candidates) nor to candidates in multiple planetary systems (about 30% of Kepler candidates),*» cautions Claire Moutou, CNRS researcher at the Laboratoire d'Astrophysique de Marseille.



Nature of Kepler planetary candidates as established by the spectrograph SOPHIE

«*These planets bring new elements into our understanding of the processes at play in the formation and evolution of planets. And brown dwarfs are the key to understanding the difference between massive planets and low-*



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mass stars, » concludes Rodrigo Díaz, CNES postdoc at the Laboratoire d'Astrophysique de Marseille.

These results will be announced on August 31st 2012 in Beijing, during the General Assembly of the International Astronomical Union. They are also presented in a series of articles recently published in *Astronomy & Astrophysics* :

- *SOPHIE velocimetry of Kepler transit candidates II. KOI-428 b: a hot Jupiter transiting a subgiant F-star* by A. Santerne et al., 2011

- *SOPHIE velocimetry of Kepler transit candidates. III. KOI-423b: an 18 MJup transiting companion around an F7IV star* by F. Bouchy et al., 2011

- *SOPHIE velocimetry of Kepler transit candidates. IV. KOI-196b: a non-inflated hot Jupiter with a high albedo* by A. Santerne et al., 2011

- *SOPHIE velocimetry of Kepler transit candidates. V. The three hot Jupiters KOI-135b, KOI-204b, and KOI-203b (alias Kepler-17b)* by A. S. Bonomo et al., 2012

- *SOPHIE velocimetry of Kepler transit candidates VII. A false positive rate of 35% for Kepler close-in giant exoplanet candidates* by A. Santerne et al., 2012

- *SOPHIE velocimetry of Kepler transit candidates VIII. Five new hot Jupiter : KOI-200 b, KOI-202 b, KOI-206 b, KOI-614 b, KOI-680 b* by G. Hébrard et al., in preparation

- *SOPHIE velocimetry of Kepler transit candidates IX. KOI-189 b and KOI-686 b : long-period very low-mass companions to solar-type stars* by R. F. Díaz et al., in preparation

- *SOPHIE velocimetry of Kepler transit candidates X. KOI-205 b and KOI-554 b : two new transiting brown dwarfs* by R. F. Díaz et al., in preparation

Notes :

¹ The spectrograph SOPHIE is an instrument installed at the 1.93m telescope of Observatoire de Haute-Provence (Southern France), at the place where the first exoplanet orbiting a Sun-like star was discovered in 1995. This spectrograph was built with the support of INSU and Conseil Régional Provence-Alpes-Côtes d'Azur and allowed the detection and characterization of about half the transiting exoplanets in the northern hemisphere (<http://www.obs-hp.fr/guide/sophie/sophie-eng.shtml>)

² More information about *Kepler* : <http://kepler.nasa.gov/>

³ The scientists involved in this study and their home institutes :



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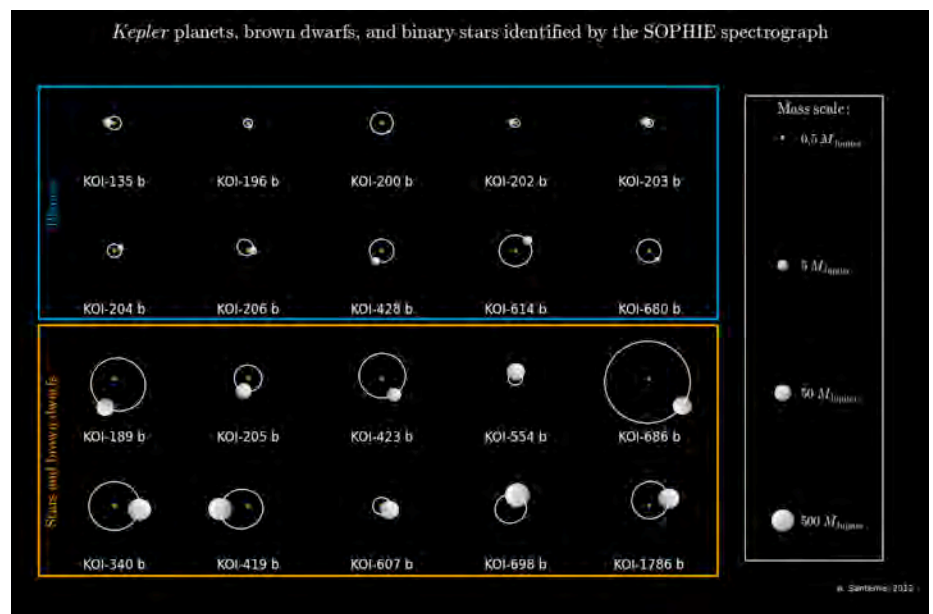
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- Observatoire de Haute-Provence (Aix-Marseille University, CNRS, UMS 3470) : A.
Santerne, F. Bouchy, G. Hébrard
- Institut d'Astrophysique de Paris (Paris-6 University, CNRS, UMR7095) : F. Bouchy, G.
Hébrard
- Centro de Astrofísica, Universidade do Porto : N. C. Santos

With the contribution of an amateur astronomer, M. Vanhuyse (Oversky).

⁴ More information about *CoRoT* : <http://smc.cnes.fr/COROT/>



Planets, brown dwarfs and binary stars found by Kepler and identified with the spectrograph SOPHIE. The size of these objects in this sketch is proportional to their mass.
Movie at: ftp.oamp.fr/pub/asanterne/kepler/PressRelease/

