Thesis subject

Name of the laboratory: Laboratoire d'Astrophysique de Marseille

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Subject's title: Modeling the populations of the low mass planets: transition between super Earths and mini Neptunes.

Subject description:
Addressing the question of the surface and atmospheric conditions of small size rocky planets, which, like the Earth, are likely to harbor life, first requires to better understand the exact nature and origin of these new populations of small planets. Whether a planet has a large H/He envelope or not has important implications for habitability. This requires not only to increase the observed sample, and determine their parameters with the highest precision, but also to confront them to models able to determine their internal structures and their composition.

The objective of this PhD thesis is to develop a complete model of planet needed to explore the populations of super-Earth and those of mini-Neptunes and further, disentangle between the two and understand their nature and evolution. To do so, the PhD student will i) continue the development of state-of-the-art internal structure models of low- mass planets our team started (see the biblio), including in particular the effects of stellar irradiation and tidal effects, ii) add a primary atmosphere or envelope similar to that of Neptune or Uranus, and iii) study the effects of stellar irradiation on the survival of this envelope. In the context of the forthcoming CHEOPS (launch fall 2019) and TESS missions (launch 2018) that will provide us with a large sample of small size planets with accurate measurements of all their basic parameters, thanks to the joint observations in radial velocities, such a model will be a key tool to support their scientific analysis and interpretation. It will provide physical arguments to quantify the transition between rocky and gaseous small planets. In addition, it will allow us to identify those, among the new detected planets, which are the best targets for their further characterization through JWST and/or ESPRESSO observations.

The PhD student will be strongly involved in the scientific exploitation of the CHEOPS space mission and the public data of the TESS mission. He/she will work in collaboration with the CHEOPS Science Team and the Planetary Systems Group at LAM. The latter is actively involved

in the development of new generation of ESA missions, CHEOPS and PLATO, but also on large radial velocity or imaging programs for the detection and characterization of exoplanets.

Bibliography:

[1] Brugger, B., Mousis, O., Deleuil, M., Lunine, J.I. 2016. *Possible Internal Structures and Compositions of Proxima Centauri b.* The Astrophysical Journal 831, L16.

[2] Brugger, B., Mousis, O., Deleuil, M., Deschamps, F., 2017 *Constraints on Super-Earths Interiors from Stellar Abundances,* 2017, ApJ 850

[3] Brugger, B., Mousis, O., Deleuil, M., Deschamps, F., Ronnet, T. 2018: *The bulk composition and internal structure of Mercury,* A&A (under revision)