Aix*Marseille université

Doctoral School 352 Physics and Science of Matter

CENTRALE MARSEILLE

Thesis subject

Name of the laboratory: Laboratoire d'Astrophysique de Marseille

Thesis advisor: Magali Deleuil
Email and address: magali.deleuil@lam.fr
Tel: 06 19 64 44 41

Co-advisor: O. Mousis
Collaborator: L. Acuna (MPIA - Heidelberg)

Subject's title: Modeling the populations of the low mass planets.

Subject description:
Since the thousands of planetary systems currently known do not resemble our solar system, understanding their composition and evolution is all the more necessary to better contextualize our solar system, and ultimately address the question of its uniqueness.

With the current generation of ground- and space-based facilities it is required to confront the planets parameters to cutting-edge models to address the question of the surface and atmospheric conditions of the small-size planet populations, understand the conditions that prevailed at the time of their formation and further constrain their likely formation site in the circumstellaire disk.

The objective of this PhD thesis is to pursuit of the developments of our model of internal structure of low-mass planets, adapted to various irradiation conditions. With its unified interior–radiative-convective atmosphere [5], the model allowed us to explore the composition, in terms of the volatile and core mass fraction, of various planets in different systems (see biblio). The objectives are now 1) to extend the range of atmospheres composition in order to model rocky planets with H_2/He- to N_2-dominated atmosphere (or more exotic species) under various irradiation conditions, 2) to implement potential atmospheric loss processes in a consistent way in order to assess the effect of irradiation on the survival of a primary envelope and its effect on the observed composition and the implications for their possible habitability. Understanding the chemistry and physics at play in these low mass-planets would bring insights into the formation and evolution of planetary

systems. On the longer term, such a model prepares for the composition analysis of temperate planets with the PLATO ESA mission.

The PhD student will be involved in international collaborations through the scientific exploitation of the programs of exoplanets characterization we are associated with. He/she will work in collaboration with the Planetary Systems Group at LAM and with L. Acuna at MPIA who developed the atmosphere layer. The Planetary Systems Group 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] Acuña, L.; Lopez, T. A.; Morel, T.; Deleuil, M. Et al: Water content trends in K2-138 and other low-mass multi-planetary systems, 2022, A&A 660, 102
[4] Acuña, Lorena; Deleuil, Magali; Mousis, Olivier et al.: Characterisation of the hydrospheres of TRAPPIST-1 planets 2021,A&A 647, 53
[5] Acuña, Lorena; Deleuil, Magali; Mousis, Olivier: Interior-atmosphere modelling to assess the observability of rocky planets with JWST, sub. To A&A