Thesis subject

Name of the laboratory: **Laboratoire d'Astrophysique de Marseille**

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Co-advisor: Prof. Jonathan Lunine, Cornell University

Subject's title: **Investigating the formation conditions of the Jovian moons in the context of the ESA/JUICE and NASA/Europa-Clipper missions**

Subject description:

General Scientific Background: the JUICE and Europa-Clipper missions have been selected by ESA and NASA as the next major exploration missions of the outer solar system. Because the launches of the JUICE and Europa-Clipper missions are planned in 2022-2025 timeframes, the science payloads of these two missions are currently being under construction. JUICE and Europa-Clipper will explore the whole Jovian system and provide constraints on the habitability and formation conditions of the Galilean moons. In this context, a strong collaboration is established with the PIs of key instruments of the JUICE and Europa-Clipper payloads (PEP, SWI and MASPEX instruments) whose aims will be to identify i) the chemical and isotopic compositions of the volatile species, and ii) their abundances in the satellites exospheres. These key data will provide useful constraints on the formation conditions of the satellites.

Objectives of the thesis: We propose a thesis based on numerical modeling and whose aim is to compel the formation conditions of Jupiter's moons via the supply of observational tests that will be measurable the science payloads of JUICE and Europa-Clipper. The origin of Jupiter's moons, discovered by Galileo in 1610, still remains poorly understood. For example, we still don't know if these satellites accreted from planetesimals condensed in the circumplanetary disk formed around Jupiter during the last phase of its growth, or if they simply originate from the primitive nebula. The work will then consist in using existing numerical codes to mimic the thermodynamic conditions that would have happened in a circumplanetary disk in which the satellites of Jupiter have potentially formed. Once the subnebula model will be constructed, the equilibrium and non-equilibrium gas phase chemistries will be investigated in this environment to obtain constraints on the composition of solids from which the satellites of Jupiter may have agglomerated. This work will be then used to constrain the specifications of the observing program to perform the critical measurements that will allow disentangling between the different scenarios. The PhD student will benefit from the expertises of Prof. Olivier Mousis and Prof. Jonathan Lunine for modeling the appropriated thermodynamic, chemical and dynamical conditions in the Jovian circumplanetary disk. The PhD student will also interact closely with the instruments teams to participate in the development of the observation strategies needed to match the measurement objectives.

Skills: The proposed topic includes an important modeling component. Good computer skills (FORTRAN programming, using UNIX shells, IDL for data processing, etc) are necessary. Candidate must have strong knowledge in thermodynamics, physics and numerical modeling. The work will be placed among collaborations in an international environment, so a good knowledge of English is required.

Bibliography:
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