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## PhD topic

Name of the laboratory: Laboratoire d'Astrophysique de Marseille

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Subject's title: Molecular dynamics in interstellar ice

### Subject description:

Interstellar ice is known to be the birthplace of complex organic molecules in dense molecular clouds where stars are forming. We want to investigate what the formation of these molecules tells us about the different steps of a star formation, from the early collapse of the dense core to the formation of the planetary system. At each step of the star formation process the ice mantle covering the interstellar grain is processed (heated, compacted, crystallized, desorbed, reaccreted, amorphized). We want to study the intimate relationship between the star formation processes, the ice mantle, and the several molecules it hosts, to be able to use these molecules as tracers of these processes at the time where radio interferometers such as ALMA and NOEMA provide us more and more high-quality observations of these molecules with an unprecedented spatial resolution.

The student will carry laboratory experiments at Aix-Marseille University, Cergy University and Max-Planck Institute at Garching on world class state-of-the-art experimental facilities. He will be part of and funded by the Astro Chemical Origins European international training network and will receive a double PhD both at the Aix-Marseille University (France) and Ludwig-Maximilians-Universität München (Germany). The candidate will have to comply with the European international training network employment rules.

### Bibliography:

\* Our astrochemical heritage, Caselli, P., & Ceccarelli, C. 2012, A&A Rev., 20, 5

\* Diffusion measurements of CO, HNCO, H<sub>2</sub>CO and NH<sub>3</sub> in amorphous water ice, F. Mispelaer, P. Theulé, H. Aouididi, J. Noble, F. Duvernay, G. Danger, P. Roubin, O. Morata, T. Hasegawa and T. Chiavassa Astronomy & Astrophysics, 2013, 555, A13

\* Thermal reactions in the ice mantle: a step towards molecular complexity in the interstellar medium Theulé P., Duvernay F., Danger G., Borget F., Bossa J. B., Vinogradoff V., Mispelaer F., Vinogradoff V., and T. Chiavassa, Advances in Space Research, 52 (4), 2013

\* Reactivity in interstellar ice analogs: role of the structural evolution, P. Ghesquiere, A. Ivlev, J.A. Noble, P. Theulé, Astronomy & Astrophysics, 2018, 614A.107G