Internship project

Level : Master 2
Title : Nonlinear dynamics of nano-confined interfaces : the force of crystallization
Institute, Group : ILM, Modélisation de la Matière Condensée et Interfaces
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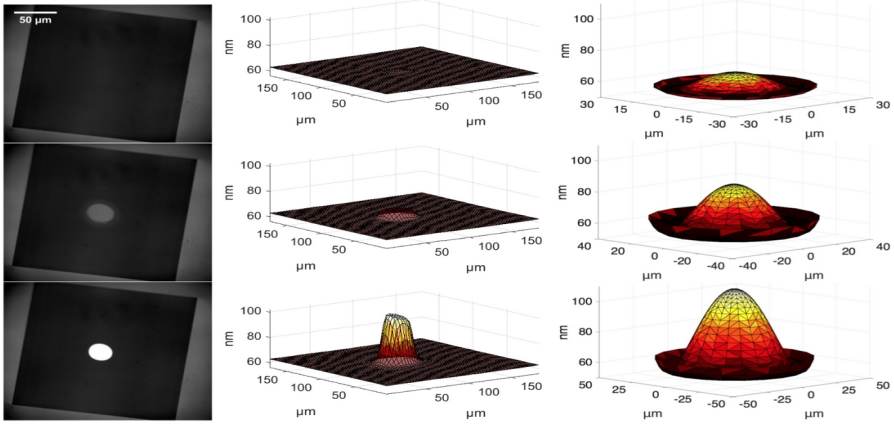
Possibiltof PhD : yes

Mots clés: Physics, Theory, non-equilibrium physics, nonlinear dynamics and pattern formation

Résumé:

Crystal growth is a model system for non-equilibrium physics. As a consequence, it has been widely studied, and in particular the nonlinear dynamics giving rise to complex shapes such as those of snow flakes have attracted much interest [1,2]. However until now, most of these studies were devoted to free growth, i.e. gowth in infinite systems. Confinement, which breaks translation invariance, gives rise to a novel class of nonlinear dynamics and morphologies[3], which are relevant in natural sciences such as geology –where crystal growth is often confined in small pores or faults of rocks, and for biomineralization, the process by which living organisms produce minerals (e.g. for their skeleton) –where growth is confined into a soft and complex environment.

One of the major consequences of the breaking of translation invariance is the appearence of a non-equilibrium force exterted on the environment during crystal growth. The aim of the project will be to study the nonlinear and non-equilibrium dynamics of these interfaces and their consequences for the force or crystallization. The modeling of the system ca be based on nonlinear continuum models [4] or on-lattice Kinetic Monte Carlo Simulations. The work can be analytical or numerical or both, depending on the profile of the candidate.



Nonlinear dynamics of the formation of a cavity in a NaClO3 crystal: (a) experimental images (Kohlert and Dysthe, Univ. of Oslo) (b) 3D reconstruction from experiments (c) model.

Références:

[1] Crystal surfaces in and out of equilibrium: a modern view, Misbah C., Pierre-Louis O., Saito Y., Reviews of Modern Physics, 82 981 (2010).
[2] *Statistical Physics of crystal growth*, Y. Saito, World Scientific.
[3] Cavity Formation in Confined Growing Crystals, Felix Kohler, Luca Gagliardi, Olivier Pierre-Louis, and Dag Kristian Dysthe, Phys Rev Lett 121, 096101 (2018)
[4] The non-equilibrium crystallization force, Luca Gagliardi and Olivier Pierre-Louis, EPL (Europhysics Letters) 127, 59002 (2019)