Internship position

Level : Master 2

Title : **Nonlinear dynamics of nano-scale solid-state dewetting**

Location : Institut Lumière Matière (ILM), LYON (http://ilm.univ-lyon1.fr/)
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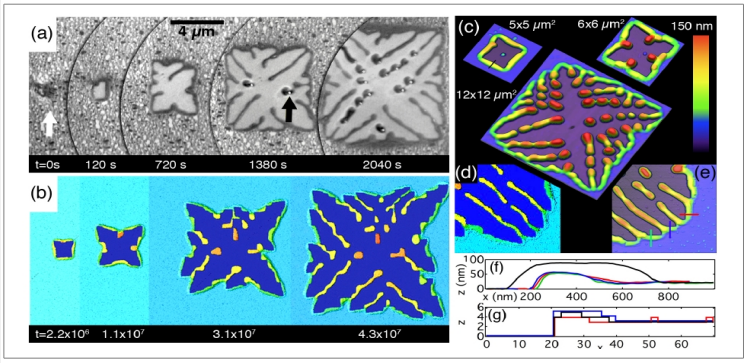
Keywords: Theory and modeling, nonlinear physics, non-equilibrium phenomena, pattern formation, nano-physics

Summary:
Due to mass transport via surface diffusion, solids can change shape at the nanoscale, leading to physical behaviors that we usually associate with liquids. As an example, ultra-thin solid films (less than 100 nm thick) can dewet just like liquids, i.e. they breakup and form droplets (see figure). Such experiments have been performed recently in several international experimental groups, and exhibit a rich variety of physical behaviors. This solid-state dewetting phenomenon differs from its liquid-state counterpart in several ways. First, as mentionned above, mass is transported by surface diffusion, instead of hydrodynamics for liquids. In addition, experiments have been performed with crystalline films, which are anisotropic. These differences lead to novel behaviors that we wish to explore.

We shall study this problem with two approaches (depending on the skills and motivation of the candidate) : (1) using on-lattice Kinetic Monte Carlo simulations where atomic diffusion is modeled via the hopping of atoms from site to site ; (2) using an analytical or numerical study of nonlinear evolution equations for the dewetting front. The shapes of the dewetting zones recall those of dendritic growth (leading e.g. to snow-flake shapes). We will for example follow the « microscopic solvability theory » approach, focusing on the key role of anisotropy, which has been successful in analyzing selection processes in the growth of dendrites.



Solid-state dewetting : Comparaison between (a,c,e,f) experiments (20nm Si film, P. Müller et al Cinam Marseille) and (b,d,g) Kinetic Monte Carlo simulations (O.Pierre-Louis, ILM, Lyon).

References:

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Possibility of PhD after internship : Yes