Stages / Internships (L3 to M2)

Nanoscale Patterns and Dynamics of Evaporation/Condensation of Salty Water

Keywords. Condensed & soft matter, percolation, nucleation, metastability, surface and capillary phenomena, micro/nano-fluidics, porous media, thermodynamics, optics, geophysics, environment, salt, water.

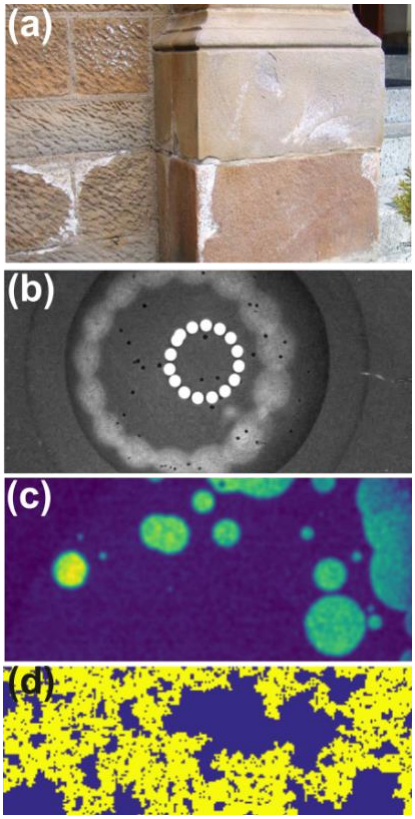
CONTEXT

We are interested in **fundamental physics** problems that are relevant in various **important societal and engineering contexts**. In particular, we study how evaporation and condensation of salty water happens in complex systems. These phenomena are crucial for e.g. **water harvesting** in dry climates, **cloud formation** in the atmosphere, new strategies for **energy production/conversion**, smart optical/mechanical **metamaterials**, sustainable architecture and **heritage conservation** (Fig. (a)), etc. but raise basic, unexplored question with rich physics.

PROJECTS

We are pursuing several investigations that combine **experiments and modeling** (theory and simulations). We are looking for a motivated student to contribute within our team making progress in one (or several) of these directions:

1) **Combined evaporation and imbibition of a drop of salty water** deposited on a nanostructured porous substrate (Fig. (b)); phase diagram of the resulting patterns and dynamics.
2) **Stochastic nucleation and growth dynamics** of new phases (crystal, vapor etc.) when the solution is trapped within the disordered structures, triggered by water potential / humidity variations (Fig. (c)).
3) **Invasion/percolation patterns** impacted by the presence of a continuously evolving field (solute concentration); Monte Carlo simulations in random 2D or 3D networks (Fig. (d)).
4) **Optical measurements** (light scattering, interferometry, spectroscopy) on nanoporous structures (ordered to strongly disordered), to probe collective phase transitions and patterns predicted by the models.



(a) Stone damage due to evaporation of salty water *[scale ~1m]*. **(b)** Imbibition of a droplet of salty water in a model nanoporous medium *[~1mm]*. **(c)** Nucleation and growth of salt crystals in disordered nanostructures *[~1µm]* **(d)** Monte Carlo simulations of phase percolation in random networks *[~1nm]* reproducing the essential features of the nanostructures.

ENVIRONMENT & SUPPORT

The internship will take place in the *Liquids and Interfaces* team of the Institut Lumière Matière (ILM), a joint laboratory of CNRS and the University of Lyon 1 (Lyon, France). The group has international recognition in the domain of the physics of liquids, soft matter and their interaction with surfaces, at scales spanning macro to nano. The project is supported by grants from Agence Nationale de la Recherche (ANR) and the European Union (FET-Open), and by various international collaborations. Continuation into PhD program is possible and welcome.

CONTACT

Olivier VINCENT
(olivier.vincent@univ-lyon1.fr, http://ilm-perso.univ-lyon1.fr/~ovincent)