Phase change in disordered media – percolation and optical effects

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Phase transitions such as evaporation, condensation and crystallization in disordered confined media appear in many situations of crucial importance, such as **condensation of droplets or ice in dust particles in the atmosphere** (strong consequences for cloud formations and climate models), or **crystallization of salts or ice in soils, rocks and building materials** (with destructive consequences that need to be avoided in heritage preservation contexts). This internship aims at investigating these phenomena both **experimentally** – with model nanoporous materials of controlled geometries subjected to temperature or humidity changes – and **theoretically**, with analytical approaches and simulations of phase change patterns in disordered pore network models (see illustrations below).

Of particular interest will be **percolation effects that arise during the growth of clusters of one phase at the expense of the other**, and the optical effects (increased scattering, sudden opacity or transparency) that occur when these clusters attain dimensions comparable to the wavelength of light. These effects will be characterized as a function of the geometry and surface properties of the disordered medium and these fundamental results may lead to applications in smart optical metamaterials.

The internship can evolve along other lines of research, including the study of other consequences of confined phase change and associated patterns (e.g. mechanical stress and associated deformations, with applications in mechanical/biomimetic smart materials or mitigation of damage in buildings and artwork), with emphasis on theory or experiments depending on the taste and aspirations of the candidate. Other possible studies include porous media drying, osmotic flows, nanofluidics etc.

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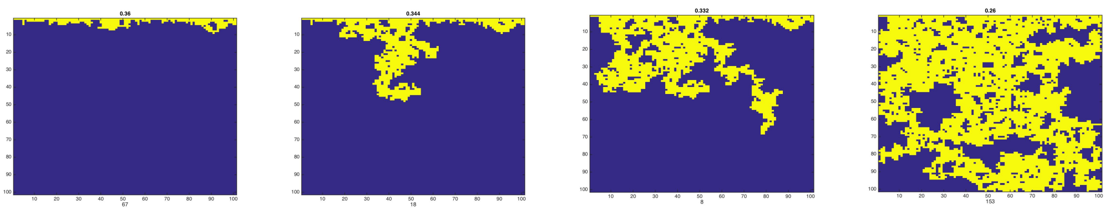

Development of gas phase clusters (yellow) at the expense of the liquid phase (blue) during evaporation in a disordered network of pores. Preliminary simulation in a 2D situation mimicking experimental conditions.