Osmotic flows driven by evaporation and condensation in microfluidics and nanofluidics

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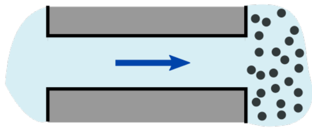
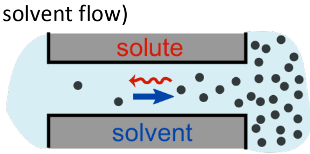
Osmosis is a process fundamental to many natural and industrial processes, from **turgor pressure in plants** and **mechanical balance in living cells** to **desalination of seawater**, **renewable energy conversion**, and **cooking or food preservation strategies**. It is one of many coupled phenomena arising at surfaces, where a gradient of solute concentration generates bulk flow, however its physical origins remain unclear, especially in partial exclusion cases.



(a) Osmosis in a semi-permeable situation (the nanopore fully excludes the solute but lets the solvent flow)



(b) Osmosis when the solute is only partially excluded by the nanopore. The induced flow depends on the physical interactions (Van der Vaals, electrostatics, sterics etc.) between the solvent and the pore surface in non trivial ways.

Recently we have shown that **micro/nano-fluidic systems** containing aqueous solutions responded strongly to variations in external water vapor pressure (i.e. relative humidity) due to **osmotic effects driven by condensation and evaporation** of water. As a result, micro/nano-fluidic platforms coupled to vapor pressure cycles provide promising ways to probe the mechanisms of osmosis.

At iLM, we fabricate **original structures combining microfluidic channels and nanoscale permeable media with well-controlled geometrical and surface properties**. The internship aims at characterizing osmotic flows and condensation-evaporation driven processes in such systems as a function of solute type, concentration, and physical interaction with the structure (e.g. screened electrostatics vs. sterics). The project will also include analytical and numerical modeling (in collaboration with the Theory team at iLM) to support the experimental investigations.