Water and ion flows in 1D and 2D nanochannels, from carbon memories to quantum friction

Lydéric Bocquet
Ecole Normale Supérieure - CNRS, 24 rue Lhomond, Paris, France
Lyderic.bocquet@ens.fr

The emerging field of nanofluidics explores the molecular mechanics of fluids. This world of infinitesimal fluidics is the frontier where the continuum of fluid dynamics meets the atomic nature of matter, or even its quantum nature. Nature fully exploits the fluidic oddities at the nanoscale and it is capable of breath-taking technological feats using a fluidic circuitry made of multiple biological channels, such as ionic pumps, proton engines, ultra-selective pores, stimulable channels, ... A major challenge at stake is to harness the strange properties of fluid transport at nanoscale to reproduce or mimick some of these functionalities.

In this talk, I will discuss various experimental and theoretical results that we obtained recently on the transport of water and ions in ultra-confinement, both in 1D nanotubes and 2D channels obtained by van der Waals assembly. I will in particular discuss the water-carbon couple, which highlights a variety of exotic transport properties. I will focus on two such phenomena: the emergence of memory in quasi–two-dimensional water channels and the development of elementary ion-based computing, with basic forms of Hebbian learning [1,2]; and the nearly frictionless flows of carbon nanotubes and its quantum roots [3,4,5].

I will conclude by briefly discussing how such nanoscale emerging phenomena can be exploited to develop technological innovations for water and energy.

References

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