PhD position
Towards new energy technologies: electromechanical couplings in nanoconfined electrolytes

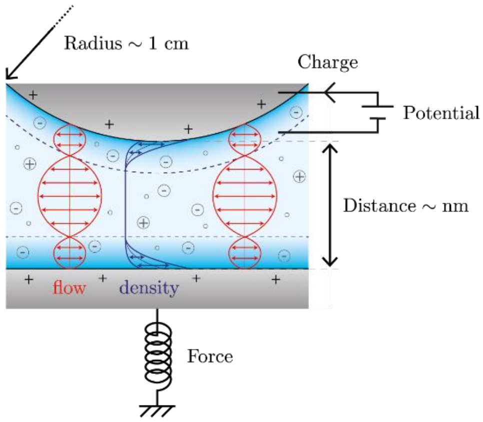
Laboratory: Laboratoire Interdisciplinaire de Physique, Grenoble, France
Team: [Soft Matter: Organization, Dynamics and Interfaces](#)

Supervisors: Romain Lhermerout (romain.lhermerout@univ-grenoble-alpes.fr)
Benjamin Cross
Elisabeth Charlaix

Contract: 3 years, funding already secured
Start date: Fall 2023

Electrolytes have a major role to play in the energy transition, not only for storage (supercapacitors, batteries, fuel cells) but also for harvesting (osmotic energy). In order to develop technologies with boosted performances, it is necessary to reach a **fundamental understanding of the physics of electrolytes under nanoconfinement** (in nanoporous electrodes or membranes). Two physical phenomena are absolutely central in these applications: the accumulation of counter-ions on charged surfaces (electrical double layer), and the generation of hydrodynamic, electric or ionic fluxes by pressure, potential or concentration gradients (electrokinetic couplings).
Existing theoretical models, based on a continuous description of matter and on a mean-field treatment of electrostatic interactions, **have never been examined experimentally**. Indeed, most studies have so far focused either on equilibrium properties (electrostatic interactions), or transport properties (electro-osmosis, conductivity, etc.), leading to inconsistent interpretations [1].

The experimental approach that we propose consists in confining the electrolyte at the nanometric scale between two macroscopic and conductive surfaces, and in **combining mechanical** (interaction force) **and electrical** (capacitance) **measurements**. This approach will ensure (i) a model geometry of confinement, and (ii) simultaneous measurements of the equilibrium and coupled transport properties.
We have developed in the team a dynamic surface force apparatus [2] and very recently an electrical bench, allowing to carry out the desired mechanical and electrical measurements. **The main objective -and challenge- of this thesis will be to combine in a unique way these two techniques, in order to probe the electromechanical couplings in nanoconfined electrolytes.**



[1] R. Hartkamp, A.-L. Biance, L. Fub, J.-F. Dufrêche, O. Bonhomme and L. Joly, *Measuring surface charge: Why experimental characterization and molecular modeling should be coupled*, **Curr. Opin. Colloid Interface Sci.** 37, 101-114 (2018)
[2] L. Garcia, C. Barraud, C. Picard, J. Giraud, E. Charlaix, and B. Cross, *A micro-nano-rheometer for the mechanics of soft matter at interfaces*, **Rev. Sci. Instrum.** 87, 113906 (2016)

Expected profile:
The candidate must be **motivated by innovative experimental work, with a strong taste for instrumentation development**, and a background in at least one of the following domains: (soft matter) physics, (fluid) mechanics, electronics, electrochemistry, physical chemistry or material science.

Application:
Interested candidates should send their application to romain.lhermerout@univ-grenoble-alpes.fr, including:
- cover letter
- CV
- transcripts from the 1st and 2nd year of the Master's program
- one or two letters of recommendation.