INTERNSHIP PROPOSAL

Laboratory name: **Gulliver**
CNRS identification code: **UMR7083**
Internship director's name: **Joshua D. MCGRAW**
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Internship location: **Gulliver / ESPCI–PSL** and **IPGG**

Thesis possibility after internship: **YES**/NO
Funding: **YES**/NO If YES, which type of funding: **ERC**

Advection and diffusion in complex, near-surface media

The dynamics of disordered systems are ubiquitous in condensed matter physics, from glasses to intracellular media. The former example is one of a complex, multicomponent mixture [1] undergoing constant decomposition and regeneration thanks to biochemical and physicochemical energy inputs. Within this mixture, each species is transported according to its local environment, comprising local fluctuations and global movements imposed by external stresses – due to an external flow, say. Taking as an emblematic object within this transport scenario, a protein molecule is an object with scale 10^1 nm, always near surface and subject to advective and diffusive motions.

During this internship, we will experimentally study an abstract and controlled version of the the complex intracellular scenario described above. Fluorescent nanoparticles take the role of a biomacromolecule, microfluidic channels are used to provide interfaces and global flow [2], while dual input channels serve to prepare non-equilibrium mixtures akin to the intracellular matrix. We use particle tracking to observe (i) the microscopic and local diffusive dynamics [3], and (ii) the advective transport there. To observe these phenomena, we use the experimental and surface-sensitive technique total internal reflection fluorescence microscopy. We thus achieve 3D, nanometrically resolved particle dynamics in near-wall, microfludic flows. Our study will bring first measurements on the impact of realistic phase decomposition dyamics at the particle level in these emblematic complex flow scenarios.

[1] J.D. McGraw, Europhysics News, **56**, 13 (2025)
[2] G. Guyard et al , Soft Matter, **17**, 3765 (2021)
[3] A. Vilquin et al., PRL, **130**, 038201 (2023)

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: **YES**/NO Soft Matter and Biological Physics: **YES**/NO
Quantum Physics: YES/**NO** Theoretical Physics: YES/**NO**