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PhD Thesis: Complex Fluids at Interfaces

Soft matter is the field of study of highly-deformable and squishy objects, at the crossroads between biophysics, chemistry, hydrodynamics, and mechanics. There, interfaces and thermal fluctuations are crucial and the elementary components, such as colloids and polymers, belong to a mesoscopic size range - between ten nanometers and a hundred microns, typically. These features make soft matter so special in the sense that the local material properties can have a very large impact at the macroscopic scale, inducing the rich and complex zoology of behaviours that we observe in everyday's life, involving: droplets, plastics and glasses, gels for food and cosmetics, liquid crystals in optical displays...

With the recent improvement of the observation techniques, such as atomic force microscopy or the surface forces apparatus, the nanoscale is now commonly accessible in experiments. There is thus a general trend towards the investigation of confinement properties of soft matter, complex fluids, and supercooled liquids, with obvious impact for fundamental science and nanotechnology. In fact, due to the mesoscopic sizes of the elementary constituents (e. g. macromolecules or colloids) one can reach quasi-2D situations where these constituents feel or become even larger than the system size, leading to anomalous flow properties, rheology, or interface-induced effects such as slip or elastohydrodynamic forces.

Within this context, the Soft Math group at Gulliver/ESPCI has developed a growing expertise in applied mathematics and physical modelling of those intriguing objects, together with a strong international collaborative network involving experimentalists and a large accessible data base. Using a combination of analytics, numerical resolutions of partial differential equations, and molecular dynamics, and organizing extended stays for our team members in our collaborators' labs, as well as weekly communications with them, we address new experimental problems and model them. Importantly, fundamental thinking also leads us to propose pure theoretical models and designs of experiments on open problems, such as the glass transition for instance.

The PhD candidate, interested by all theses aspects of our activities, ranging from modelling of concrete experimental questions to developing of fundamental theories on complex fluids at interfaces, should not hesitate to visit our websites and contact us for more details.

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