

Sujet de stage de fin d'études Master

Titre/Title	Squeezing Particles into a Constriction: AI-Based Data Analysis
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Laboratoire/Laboratory	BMBI
Mots clés/Key words	Particles, Flow, Pores, Constriction, Machine Learning, Data Analysis
Descriptif du sujet/ Project description	Scientific context - <i>How do soft particles squeeze through narrow pores?</i> This question is relevant to many applications in biological flows, environmental transport, and biomedical microfluidic devices. When deformable particles flow through a constriction, their interactions with the walls and with neighboring particles can lead to complex behaviors, such as, collisions, aggregation and eventually clogging of the constriction. We study these phenomena using fully three-dimensional computer simulations of fluid-filled capsules, performed with our in-house software. By varying key parameters such as the applied flow, number of particles, particle deformability and constriction width, we generate large data-sets covering a wide range of dynamical regimes. Project objective - The main goal of this project is to develop AI based tools for analyzing and extracting automatically information from these large simulation datasets. The student will investigate machine learning and computer vision methods to: • automatically detect and track individual particles, • extract particle trajectories and velocities, • identify particle-particle and particle-wall interactions, • classify different dynamical regimes, such as passage, and aggregation, • identify patterns linking simulation parameters to the observed dynamics. Required skills - This interdisciplinary project combines computational physics, fluid mechanics, data analysis, machine learning and computer vision. It offers an opportunity to work with large-scale simulation data and develop AI tools for analyzing complex physical systems. Depending on the student's interests, the developed methods can also be applied to other soft-particle systems, including existing datasets of red blood cells flowing through microfluidic channels.