INTERNSHIP PROGRAM FOR INTERNATIONAL STUDENTS

INTERNSHIP SUBJECT FORM

Name of the Host Laboratory	LadHyX
Website of the Host Laboratory	https://www.ladhyx.polytechnique.fr/en/
Research Group	
Internship Supervisor	Blaise Delmotte and Daniel M. Abrams (Northwestern University, USA)
Internship Subject	A dynamical system approach to self-assembly in microroller suspensions
Student's level	☐ Advanced Undergraduate Students (3rd or 4th year) ☒ Master's students (1st or 2nd year) ☒ PhD students
Proposed Duration	☐ 3 months ☐ 4 months ☒ 5 months ☒ 6 months
Prerequisites	Dynamical Systems, Applied Mathematics, Low Reynolds number Hydrodynamics,
Internship description (max. 15 lines)	The dynamics of active particles suspended in a fluid can display surprising behaviors. Recent work has identified persistent cluster states which were shown to be assembled and held together by hydrodynamic interactions alone [Driscoll et al. (2017) Nature Physics, 13(4), 375]. These states were seen in systems of colloidal microrollers; microrollers are small heavy particles which rotate about an axis parallel to the floor under the action of an external torque, and generate strong, slowly decaying flows. The superposition of these flows fields leads to spontaneous self-assembly into stable motile structures, observed both in experiments and large-scale simulations. The goal of this internship is to study this spontaneous self-assembly with a dynamical system approach. The student will first study a simple, yet rich, model system of two microrollers. Pairs of microrollers can exhibit hydrodynamic bound states whose nature depends on a dimensionless number, denoted *B*, which compares the relative strength of gravitational forces and external torques. A dynamical system approach reveals that the system undergoes a variety of bifurcations in phase space as *B* varies. He/She will then study suspensions of microrollers at the macroscopic scale, with a continuum model. In particular, he/she will look for steady-state solutions of the system and see if they correspond to the self-assembled structures observed in simulations and experiments. This internship connects well-known concepts from dynamical systems to fluid mechanics, lab experiments and state-of-the-art research.