INTERNSHIP PROGRAM FOR INTERNATIONAL STUDENTS

INTERNSHIP SUBJECT FORM

Name of the Host Laboratory	LadHyX
Website of the Host Laboratory	www.ladhyx.polytechnique.fr
Research Group	
Internship Supervisor	Sébastien Michelin
Internship Subject	Self-propulsion of active micro-particles: Shape & instability
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	Viscous flows, diffusion, partial differential equations, some Matlab/Python experience
Internship description (max. 15 lines)	Synthetic « micro-swimmers » fascinate many for their potential biomedical applications (e.g. targeted drug delivery) or to understand collective dynamics of small-scale physical systems (in contrast with crowds and fish school dynamics). Unlike miniaturized robots, active particles have no moving parts, require no microscopic assembling, and draw their chemical energy directly from their immediate environment, thus allowing for much simpler and cheaper designs. They swim by combining a chemical *activity* (chemical reaction) and a phoretic *mobility* (i.e. the ability to drift in the chemical gradients they create by their catalytic activity). Two main strategies are available to break the front-back symmetry: (i) asymmetric designs (e.g. a ``Janus'' particle) or (ii) instabilities which result from the nonlinear coupling of chemical advection to the resulting fluid flows. Symmetric systems swim by exploiting the latter: beyond a critical advection-to-diffusion ratio, a self-propelled swimming state arises. The shape of the particle itself plays a key role on the coupling of chemical transport and hydrodynamics, yet most models of instability-based swimming focus exclusively on spheres. The present internship will thus focus on the impact of particle shape and its control of these particles' self-propulsion using a combination of linear stability analysis and numerical simulations.