Post-doc offer:

PhotoRheo: Stress-Induced Bioluminescence as a Stress Sensor in Complex Fluids

Context: Dinoflagellate cells are able to emit bioluminescence. Some species, like Lingulodinium Polyedrum (LP), emit bright blue light flashes once submitted to a shear stress. This is supposedly related to a defence mechanism against predators. From the physics point of view, these cells can be viewed as local stress sensor. The intensity of light has been shown to be proportional to the applied stress (Maldonado & Latz, 2007; Marcinko et al., 2013; Cussatlegras & Le Gal, 2007).

Project: In this project, we propose to visualise and measure elongation and shear stresses in low Reynolds (Re) flows of complex fluids by means of stress induced bioluminescence of microalgae Gonyaulax Lingulodinium Polyedrum (LP).
Indeed, the existing stress measurement techniques are always indirect: a proxy such as strain or displacement is measured, from which stresses are subsequently interpreted. If a constitutive law between stress and strain law is lacking (which is usually the case for complex fluids) these techniques cannot be used. We strongly believe that our project will help to elaborate a direct measure of stress in any kind of complex material once bioluminescence induced by shear and extensional stress will be calibrated on a simple fluid.
In the literature, a lot of studies have been achieved to measure shear induced bioluminescence of LP in a simple fluid but in order to characterise stress in complex fluids (like polymer solution for example), bioluminescence response to extensional stress is important. Therefore, we want to calibrate LP bioluminescence induced by extensional stress of a simple fluid. Polymer solutions and colloidal gels will be used to alter the flow curve and tune the rheological behaviour in terms of viscosity and elasticity. The stress map will then be drawn from luminescence measurements. We chose these two different kinds of complex materials to test this new method of stress measurement.

Skills: The Post-doc fellow will have a Mechanics/Physics background: soft condensed matter, bases in hydrodynamics and mechanics of continuum media.
The research work will mainly involve experimental work. Microfluidic experiments coupled to low light microscopy imaging will be performed. This implies clean room microfabrication (LIPHY). Data analysis will consist mainly in image analysis and particle tracking (LIPHY). This needs basic knowledge in programming. In the lab, the programming language used for data analysis and image processing is Python.

Although the project implies to work with a living organism, a biology background is not needed. Indeed the necessary training to handle cell culturing is usually taken in a couple of weeks (LIPHY). Experiments on elongation rheometry will be performed at LRP.

Host teams:

The location will be on Grenoble's academic campus, 15 mn tramway and 12 mn bike from Grenoble's center. This project is a collaboration between two labs of the campus, LIPHY and LRP. The LIPHY team works since several years on the hydrodynamics of motile micro-algal suspensions. The LRP team masters the technology allowing the stress and strain rate measurements on flows of complex fluids.

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Funding:

The postdoc is financed by Laboratory of Excellence TEC21; salary expectations are based on the grid set up by the CNRS (min. 2300 euros brut / month). Duration: 12 months. Beginning: April to sept. 2018.

Contacts:

Research will be performed in collaboration with Salima Rafaï, Philippe Peyla, Olivier Stephan from LIPhy and Frédéric Pignon, Hugues Bodiguel from LRP.
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