Research Topic for the ParisTech/CSC PhD Program

Subfield: Physics

ParisTech School: ESPCI

Title: Fluid-structure interaction: Flexible fiber interacting with a dense granular medium

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Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

The study of fluid-structure interactions has been traditionally developed in the context of mechanics and engineering for optimizing structures against wind or water flow. Recently there have been fundamental works dealing with the drag reduction and reconfiguration of flexible objects into streamlined shapes in controlled water or air flows. In our work, we investigate a new fluid/structure interaction in the unusual case of a dense granular medium flowing against an elastic fiber acting as a flexible intruder.

The mechanical resistance produced by the cluster of grains contacting the fiber tends to bend or buckle the flexible intruder, which in turn modifies the granular flow. We study the reconfiguration of the fiber as a function of the fiber's rigidity and of the granular packing fraction close but below the jamming. We now propose to focus on the granular flow fields and to establish their correlations with the fiber's deflexion as well as with the forces experienced by the fiber. Experimental results will also be compared with *Elastica* simulations for different loadings along the fiber.

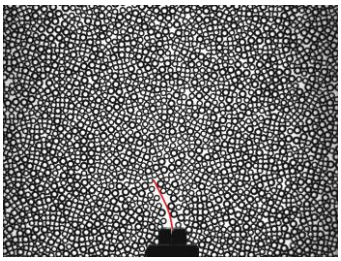

Fig.1a : Experimental view of a flexible fiber deflected by a 2D granular flow.

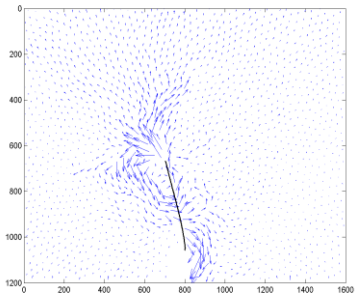

Fig.1b : Amplified grain displacements around the reconstructed flexible fiber (in the plate frame).

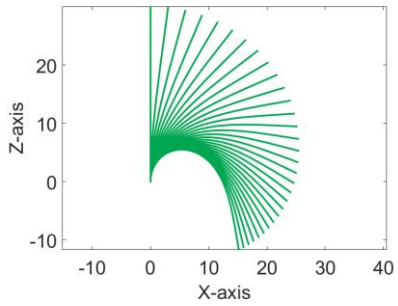

Fig.1c: Elastica simulations of a flexible fiber submitted to a distribution of orthogonal forces with increasing amplitudes.

Required background of the student: physics

A list of 5 (max.) representative publications of the group: (Related to the research topic)

- https://doi.org/10.1051/epjconf/201714014002
- Kolb E., Cixous P., Charmet J.C., 2014. *Flow fields around an intruder immersed in a 2D dense granular layer;* Granular Matter, 16 , 223.
- Kolb E., Cixous P., Gaudouen N., Darnige T., 2013. *Rigid intruder inside a two-dimensional dense granular flow: Drag force and cavity formation* Phys. Rev. E, 87, 032207.