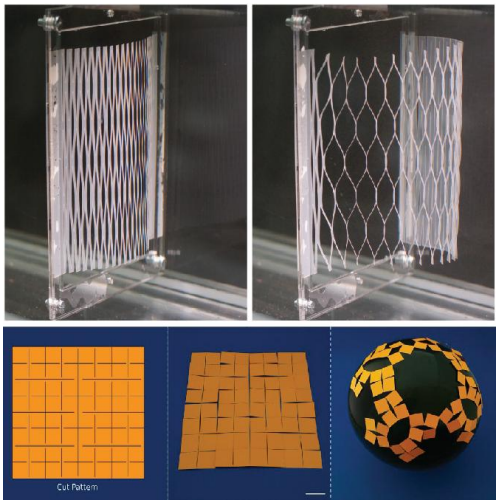
Post-doctoral position available

Kirigami: tailoring the behavior of flexible surfaces in flows



The engineering of devices operating in flows increasingly favors compliant components over rigid ones. The ability to passively change shape makes them more resilient and adaptable to fluctuating fluid environment. Shape-shifting can also serve functional purposes, such as enhancing aerodynamic performance for flexible airfoils or regulating flows for soft valves [1]. Soft components however pose a design challenge, as they are intrinsically more difficult to control than rigid ones. Effort is thus made to understand mechanisms governing deformation in a flow [2], and expand accessible shapes.

Recently, kirigami cutting principle has emerged as a promising design tool for stretchable and morphable structures [3]. The slit pattern embedded into sheets conditions their mechanical properties, producing engineered elasticity. It also allows flat surfaces to change shape through local extension enabled by slits, with industrial applications as diverse as conformable robotic skins, electronics or sensors. Our group in LadHyX is currently studying how this kirigami technique can further be leveraged to steer deformation in a flow [4]. The postdoctoral researcher will join this thematic, tackling questions such as: How do flows force the expansion of kirigami sheets? How do the extreme shape changes feedback on the fluid? What is the role of the cut pattern in those processes? Those questions will be addressed through a combined experiment/modelling approach, to identify the rational design principles to program shape morphing through cuts. Depending on her/his taste and profile, the candidate will have the possibility to study other related topics.

Context: The work will be mostly experimental, characterizing the flow-induced deformation of kirigami sheets with generic slit patterns (involving imaging techniques, flow visualizations, force measurements). It will be coupled to theoretical modelling, drawing from previous models for the deformation of flexible structures under fluid loading [2]. The work will be performed at LadHyX, which is a Fluid Mechanics and interdisciplinary research laboratory at Ecole Polytechnique, near Paris. The candidate will join the ANR-funded project FLORIGAMI, coordinated by S. Ramananarivo, Assistant Professor at LadHyX. Two PhD students will be working on other aspects of this project. Synergetic interactions are thus expected, and the candidate should be motivated to work in a collaborative environment.

Candidates should hold a PhD degree and have experience in at least one of these areas: fluid mechanics, fluid/structure interaction, mechanical metamaterials (in particular kirigami/origami), or continuum mechanics. A strong taste for both experiments and theoretical analysis is a plus. English proficiency and oral communication skills will also be a factor, as participation in international conferences are expected.

Lab : LadHyX (https://www.ladhyx.polytechnique.fr/en/), Ecole Polytechnique, France
Dates : 2 years, starting as soon as possible
Monthly gross salary: between 2800€ and 3700€ depending on experience
Contact : Applicants are welcome to directly contact Sophie Ramananarivo with a detailed CV, and the names and email addresses of two references (sophie.ramananarivo@ladhyx.polytechnique.fr).

---

[1] S. Ramananarivo, R. Godoy-Diana & B. Thiria (2011). Proc. Natl. Acad. Sci., 108(15), 5964-5969.
[2] Gosselin, E. de Langre & B. A. Machado-Almeida (2010). J. Fluid Mech., 650, 319-341.
[3] S. J. Callens & A. A. Zadpoor (2018). Mater. Today, 21(3), 241-264.
[4] T. Marzin, K. Le Hay, E. de Langre & S. Ramananarivo. (2022). Phys. Rev. Fluids, 7(2), 023906.