B.Sc. / M.Sc. project: Machine Materials

What?

Develop the physics of Machine Materials, i.e. artificial materials which combine microstructure and out-of-equilibrium processes to interact with their environment in a programmable fashion.

Why?

To develop novel materials and to understand nonlinear couplings between elasticity and active processes.

How?

By 4D printing, i.e. 3D printing hydrogels, which become active under osmotic shocks.

Who?

If you believe to be an outstanding student with interests in soft matter, elasticity and/or metamaterials, feel free to contact Corentin Coulais.

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Summary

Over the past few years, exciting progress has been made in the field of mechanical metamaterials. Harnessing nonlinear degrees of freedom arising in suitably designed microstructures, metamaterials could be programmed with specific mechanical tasks, such as negative stiffness, elastic hysteresis or programmable mechanics *(1-4)*. So far, most of these developments have been made with passive—at equilibrium—materials.

The goal of this project is generalize these findings to create a new class of programmable, dynamical and active materials, called *Machine Materials*. To do this, the idea is to set the grounds of nonlinear *osmomechanics*, which combines swelling and nonlinear elasticity within metagels, i.e. architected hydrogels under osmotic shock.

References

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3. Coulais, Teomy, de Reus, Shokef and van Hecke, Combinatorial Design of Textured Mechanical Metamaterials. *Nature* **535**, 529-532 (2016).
4. Coulais, Sounas, and Alù, Static Non-Reciprocity in Mechanical Metamaterials. *Nature*, **542**, 461-464 (2017).