Master 2 internship proposal

Physique et Mécanique des Milieux Hétérogènes

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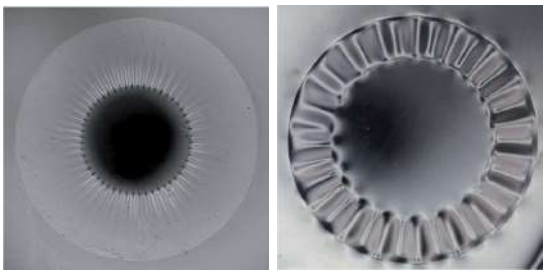
Stress reversal by a strong nonlinearity: an elastic sheet toy model

Living cells move thanks to nanometer-size molecular motors whose forces are transmitted up to the scale of the cell by a fiber network known as the cytoskeleton. On much larger length scales, individual cells generate forces that are similarly transmitted to the tissue level through the fibrous extracellular matrix. While the biology of these processes is rather well characterized, the simple problem of force transmission through these highly nonlinear elastic media is far from trivial, and leads to a **conversion of local extensile forces to contractile stresses**, with crucial biological implications.
To better understand this surprising physical behavior, we will set up a model force transmission experiment where the role of the nonlinear elastic medium will be played by a thin plastic sheet floating on water. By locally exerting extensile forces at the center of the sheet by inflating a balloon, we will **directly observe how the forces are rectified through the wrinkling of the sheet**. The goal is to help explain why the cytoskeleton is always contractile despite containing a significant number of extensile motors, and to inspire the design of counter-intuitive materials that contract when they should extend.



Floating elastic sheets wrinkle under force, which induces a strongly nonlinear effective response akin to that of biological fibrous media.

Expected skills: The student will have a taste for experimental physics. He/She will set up and run a model experiment, and participate in the theoretical analysis of the measurements.