Postdoc 2025

Forces exerted by swelling granular media using seeds and hydrogel beads

The context Plants do not possess a heart to drive the circulations of their internal fluids, but rely on two mechanisms: osmotic pressure and evaporation. These two mechanisms are actively regulated by either the production of solutes or the opening of evaporation sites, respectively. The osmotic effects lead to high turgor pressures, that are responsible for maintaining the shape of non-lignified plants. Here we are interested in a specific aspect linked to water transport: the rehydration of dessicated seeds. Under water seeds attract water through osmotic effects leading in a strong volume increase and possibly strong pressures. Plants seeds act as elements of peculiar type of granular media, not really studied in literature: swelling granular media.

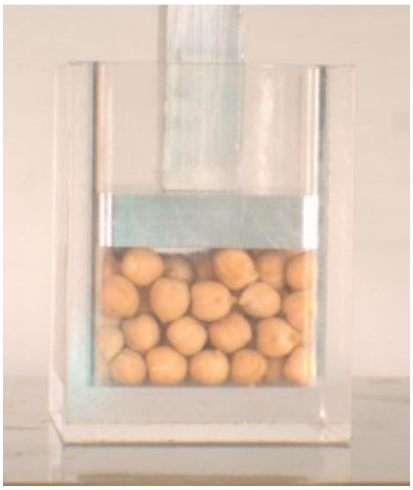
(a)  (b) 

Figure
(a) Chickpea swelling under water : Piston and chamber to measure the considerable forces
(b) Squeezed artificial hydrogel beads in a tube.

Objectives The main objective of the post-doc is to understand the physics of imbibition of these granular media. First we will tackle the temporal dynamics of imbibition of single seeds/grains in water, using seeds as chickpeas because of their near spherical shapes. Histological sections will be performed to understand which cells are swelling. Second we will measure the forces exerted by grains when they are hydrated confined in spaces, such as in between two planes, in a tube or within a chamber. Preliminary experiments show dozen of bars in pressure. Third we will generalize this findings with different types of plant seeds or artificial hydrogel materials. Finally, we aim at using this granular media as an autonomous media to exert pressures by sole imbibition reproducing the phenomenon of turgor pressure.

The internship is mainly experimental but involves theoretical modelling.

Environment Laboratoire Interdisciplinaire de Physique is located on the Grenoble campus, France.

Supervision The student will work in a team with Philippe Marmottant (physics of plants) as Internship advisor, together with Catherine Quilliet (modelling), Olivier Stephan (3D manufacturing, hydrogels) and Pierre Recho (theory of porous media).

Collaboration The work proposed will be in collaboration with biological researchers, to deepen the physiological significance of the findings and produce anatomical observations.

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