Hydromechanical field theory of plant morphogenesis

Hadrien Oliveri*[1] and Ibrahim Cheddadi[2]

[1]Max Planck Institute for Plant Breeding Research – Germany
[2]Laboratoire TIMC-IMAG – Université Grenoble Alpes – France

Abstract

The growth of plants is a hydromechanical phenomenon in which cells enlarge by absorbing water, while their walls expand and remodel under turgor-induced tension. In multicellular tissues, where cells are mechanically interconnected, morphogenesis results from the combined effect of local cell growths, which reflects the action of heterogeneous mechanical, physical, and chemical fields, each exerting varying degrees of nonlocal influence within the tissue. In this talk, I will present a physical field theory of plant growth describing this process. This theory treats the tissue as a poromorphoelastic body, namely a growing poroelastic medium, where growth arises from pressure-induced deformations and osmotically-driven imbibition of the tissue. From this perspective, growing regions correspond to hydraulic sinks, leading to the possibility of complex non-local regulations, such as water competition and growth-induced water potential gradients. More in general, this work aims to establish foundations for a mechanistic, mechanical field theory of morphogenesis in plants, where growth arises from the interplay of multiple physical fields, and where biochemical regulations are integrated through specific physical parameters. arXiv preprint arxiv.org/abs/2409.02775

*Speaker