LadHyX Seminar – June 4th, 10:45

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Morphing without Muscles: Hydraulic Actuation in nature

Programming the movement of soft structures that expand, morph, or passively respond to external stimuli remains a significant challenge for conventional engineering approaches. In contrast, the natural world offers a rich source of inspiration, particularly among plants and insects. Plants, with their limited motility, have evolved ingenious strategies to move or reposition parts of their structure, while holometabolous insects undergo dramatic metamorphoses, transforming from larval to adult forms.

A particularly striking example occurs during the final stage of metamorphosis in insects: the rapid deployment of wings immediately after emerging from the pupal case. In Drosophila melanogaster, this wing expansion happens within minutes, a remarkable feat at the scale of a developing organ. This phenomenon appears to be driven primarily by physical mechanisms, notably hydraulic actuation. In this talk, I will explore the hydraulic mechanisms driving wing expansion in Drosophila, presenting a simple mechanical model that captures the essential features of this process. I will then show how, in Mimosa Pudica, local water transfer between cells and surrounding air-filled cavities provides an effective strategy for generating rapid hydraulic movements, circumventing the limitations of long-distance water transport.