LadHyX Seminar – September 5th, 10:45

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Towards models of fluid transport in active vascular networks

Liquid flows in vascular networks are among the most effective ways to transport matter and information for life. From animals to fungi, the most adaptable organisms utilize vascular networks with vessels that actively contract upon local sensing of stimuli instead of central pumping mechanisms. These self-contractions bring unique autonomous functionalities such as adaptative locomotion and resilient immunity defense. To finely control fluid flows in these networks and properly deliver matter and information, living organisms combine both passive and active interactions. One striking example is the lymphatic system in which interstitial fluids are transported across the whole body of mammals against intricate changes of pressures. In the collecting lymphatics, lymph is transported via active vessel contractions combined with passive leaflets that ensure unidirectional transport. The nature of the active contractions, the multi-scale and multi-physics of the system make it challenging to model. In the first part of this seminar, I will describe how the development of artificial models inspired by the lymphatic system enables systematical studies on the role of leaflets and channel contractions. In the second part of this seminar, I will present the first steps toward the development of robotic matter capable of mimicking active self-actuations observed in nature. Model experiments combining passive elasticity and local active forces are used to develop models predicting the mechanical properties of such active materials and demonstrate how the interplay between dissipation, restoring forces and active forces controls their dynamics. These results open the way to a better understanding of fluid transport in self-contracting networks and the reproduction of living matter functionalities in artificial systems.