Physics Colloquium

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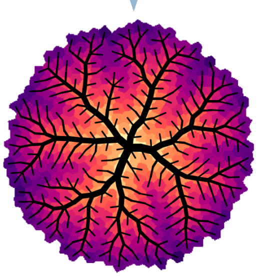
The spectrum of efficient venation phenotypes

Life above a certain size relies on a circulatory system for oxygen and nutrient delivery. Without it, no complex animal would exceed a few millimeters: by diffusion alone, oxygen would not be able to travel more than 100μm in the tissue. Plants, animals and fungi have developed circulatory systems of striking complexity to solve the formidable problem of nutrient delivery and waste removal. Typically, biological transport networks have to satisfy competing demands to operate efficiently and robustly while confronted with an ever-changing environment. The architecture of these networks, as defined by the topology and edge weights, determines how efficiently the networks perform their function. **In this talk** we present some general models regarding the emergence and function of biological transport networks, from the reticulate vascular architecture of the leaf, to the hierarchies of the veins and arteries in our brain. We demonstrate that the network topologies generated by adaptation represent a trade-off between optimizing power dissipation, construction cost, and damage robustness. We identify the Pareto-efficient front and eventually the spectrum of venation phenotypes that evolution is expected to favor and select. Next, inspired by hemodynamic fluctuations in the brain, we examine how a network can dynamically adapt to reroute flow to prescribed network locations. In particular, we investigate how many simultaneous functions a given network can be programmed to fulfill and we uncover a phase transition that is related to other constraint-satisfaction transitions.



Eleni Katifori *graduated with in B.Sc. degree in Physics from the University of Athens, Greece. She then moved to Harvard, where she obtained her Ph.D. degree in Physics in 2008, followed by a fellowship at the Center for Studies in Physics and Astronomy at Rockefeller University in New York. In 2012 she started a position as an independent group leader at the Max Planck Institute for Dynamics and Self-Organization in Goettingen. In 2015 she returned to the US to join the faculty at the University of Pennsylvania as an Assistant Professor. Eleni Katifori is a recipient of a Burroughs Wellcome Career Award at the Scientific Interface and an NSF Career Award. Her research interests are primarily theoretical, and span broad areas from soft matter physics with a focus on biologically inspired physics, thin shell elasticity and biological transport networks.*

Thursday March 22 at 4:10PM in LL. 316