Next IPC - April 26 - Prof. Jean-François Joanny

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Beating of artificial Cilia

Many biological systems use the beating of cilia either to propel themselves or to induce fluid flow around them. Recent experiments in the group of Pascal Martin at Institute Curie study the beating of self-assembled actin bundles anchored on a solid surface induced by myosin motors, which can be considered as artificial cilia. In addition to the beating pattern of each cilium, the experiment images a wave of myosin motors along the cilium.

Classical theories describe the beating cilium as a bending slender beam immersed in a viscous fluid dissipation being due to the external hydrodynamic drag of the viscous fluid. The beating is created by an active mechanism internal to the cilium and due to molecular motors.

I will present in this talk a very generic theory of cilia beating that includes the various types of external and internal dissipation and of active forces propelling the cilium and that explicitly considers the molecular motor distribution along the cilium. The theory is based on the entropy production on the cilium and the various dissipative forces are obtained from Onsager force-flux relations. The active forces are related to myosin motor densities along the cilium obtained from binding and unbinding kinetics for the motors.

A simple version of this theory in two dimensions provides a quantitative description of the experiments on artificial cilia done in the group of Pascal Martin.

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