MPIDS Colloquium

MAX-PLANCK-GESELLSCHAFT

Beating of artificial cilia

Prof. Dr. Jean-François Joanny

Collège de France
and Institut Curie
Paris, France

Recent experiments in the group of Pascal Martin study the beating of spontaneously formed actin bundles anchored on a solid surface. induced by myosin motors. In addition to the beating pattern of each cilium, the imaging technique studies the wave of myosin motors propagating from the anchoring head of the filament to the free end. The mechanical wave propagates at constant velocity and the myosin wave propagates at twice this velocity. They also show clearly that the binding of myosin motors to actin increases strongly with the local curvature.

The classical theories for cilia or flagella beating describe the beating cilium as a bending slender beam immersed in a viscous fluid. Dissipation is 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. It is described either by a phenomenological force distribution along the cilium or by an explicit model of 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 myosin distribution along the cilium.

In addition to the external dissipation, two types o internal dissipation associated to the shear and the curvature of the cilium can play a role. The theory starts from the expression of the entropy production on the cilium expressed as a function of 3 variables: the local position, the local orientation and the local curvature. 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 depending on local curvature.

I will present a simple version of this theory in two dimensions and compare it to the experiments done in the group of Pascal Martin.

Wednesday, May 27th, 2020 at 2:15 pm

MPIDS, video conference at www.zoom.us
Meeting ID: 989 4089 1985
Password: 335976, direct link

Max Planck Institute for Dynamics and Self-Organization
Living Matter Physics
Prof. Dr. Ramin Golestanian
Email: ramin.golestanian@ds.mpg.de, Phone: +49-(0)551/5176-101
Am Faßberg 17, 37077 Göttingen, Germany