# Fluid-structure interactions of membrane wings

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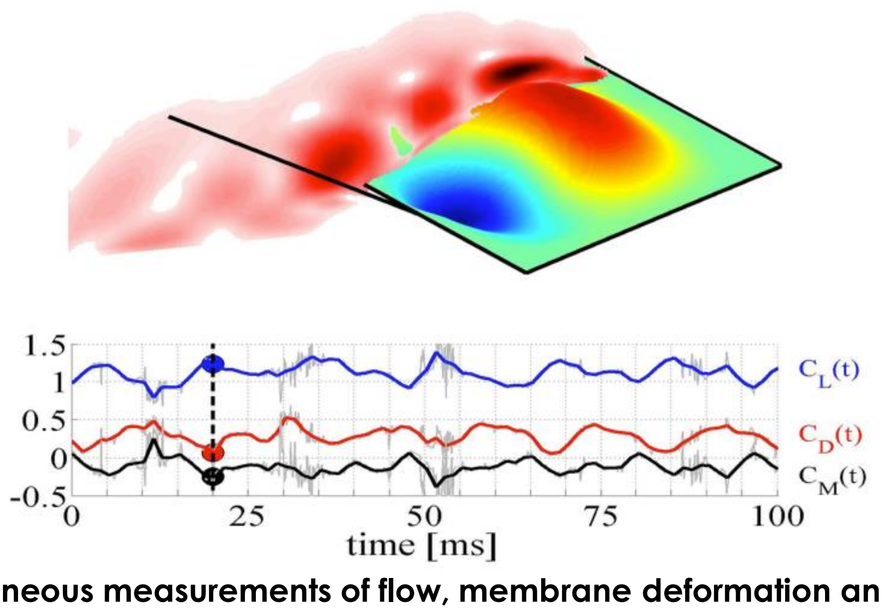
**Abstract**

Natural fliers achieve exceptional aerodynamics by continuous adjustments of their geometry through a mix of dynamic wing compliance and distributed sensing and actuation. This enables them to routinely perform a wide range of maneuvers including rapid turns, rolls, dives, and climbs with seeming ease.
This suggests that the use of active and passive compliant wings will enhance the aeromechanics of a Micro Air Vehicle (MAV). In this paper, we will present some experimental results that show the superior aerodynamic performance of passive membrane wings compared to traditional rigid wings. Membrane wings operating at a chord-based Reynolds number of 55000 show higher lift and higher or comparable efficiency due to flow-induced cambering and unsteady oscillations of the membrane. Simultaneous force, membrane vibration and velocity field measurements reveal that the force fluctuations are coupled to mode shapes in the membrane that are caused by passage of vortices over the top surface of wing. This fluid-structure coupling suggests that it might be possible to tune the material properties on-the-fly to realize "on-demand" aerodynamic performance. Recent experimental results using electroactive membrane wings show that it is indeed possible to tailor the aerodynamic performance using integral actuation that alters the material properties. This opens the possibility of using these electroactive wings for flight control.




**Simultaneous measurements of flow, membrane deformation and loads**