Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Quasi-Steady Limit of Flow Structure on Flapping Wing in Mean Flow MATTHEW BROSS, CEM OZEN, DONALD ROCKWELL, Lehigh University — A limiting case of flapping motion of a wing (low aspect ratio plate) in presence of incident steady flow is compared to a rotating wing in quiescent fluid, in order to clarify the effect of advance ratio J (ratio of free-stream velocity to tangential velocity of wing) on the structure of the leading-edge vortex. Stereoscopic particle image velocimetry leads to patterns of vorticity, velocity contours, and streamlines. For each value of J, the effective angle of attack is held constant at 45°, while the wing rotates from rest through 270°. While at rest, the wing at high angle of attack in the presence of a steady free-stream gives rise to fully stalled flow. After the onset of rotation, the fully stalled region very quickly transforms to a stable leading edge vortex. Despite the change in advance ratio, the development of the flow structure around the wing throughout the rotation maneuver is similar, especially in the leading edge vortex region, as evidenced by patterns of streamline topology. To further demonstrate the effect of J, three-dimensional representations of of spanwise-oriented vorticity, spanwise velocity, and Q were constructed for hovering flight and forward flight.

Matthew Bross
Lehigh University

Date submitted: 02 Aug 2012 Electronic form version 1.4