Abstract Submitted
for the DFD06 Meeting of
The American Physical Society

Numerical and experimental study of flexion in flapping-wing fluid dynamics JEFF ELDREDGE, JONATHAN TOOMEY, University of California, Los Angeles — The wings of airborne insects are flexible structures that permit considerable out-of-plane deformation during the flapping cycle. However, it is not clear what aerodynamic role is served by this flexion, nor is it clear to what degree it is coupled with the fluid forcing. In this work we investigate the flapping of a two-dimensional wing composed of two rigid sections connected by a torsion spring. The motion of the leading section is prescribed with hovering-flight kinematics, and the trailing section responds passively. The complexity of a continuously flexible structure is thereby circumvented by isolating the flexion in the deflection of the spring. Numerical simulations of the coupled fluid–body dynamics are performed with a viscous vortex particle method. The wing behavior is studied experimentally with a dynamically-scaled system in a water tank with two-degree-of-freedom motion control. Experimental measurements of the torsion spring deflection are used to validate the numerical methodology, with excellent agreement. The force production and energy consumption are examined by analyzing the numerical simulation results. In comparing the flapping of a flexible wing with a fully rigid one, it is found that the flexible wing generates smaller lift forces and requires considerably less power.

Jeff Eldredge
University of California, Los Angeles

Date submitted: 04 Aug 2006 Electronic form version 1.4