Abstract Submitted
for the DFD06 Meeting of
The American Physical Society

Fluid-Structural dynamics of flapping, flexible airfoils[1] MARCOS VANELLA, SERGIO PREIDIKMAN, ELIAS BALARAS, BALAKUMAR BALACHANDRAN, Dept. Mechanical Engineering, University of Maryland — In recent years, flapping flight has received considerable attention and many studies have been pursued in the fluid dynamics community by using simplified two-dimensional rigid airfoils and three-dimensional rigid wings with prescribed kinematics. Although these studies provide important insights and help explain experimental observations, the coupled fluid-structural dynamics of flexible, flapping wings remains largely unexplored. In order to understand this dynamics as well as to gain insights into insect flight, numerical studies of a two-part hinged plate configuration with a flexural coupling moving in a viscous fluid are conducted. The two-part configuration is described by a set of four coupled, nonlinear second-order differential system, and this system in conjunction with the Navier-Stokes equations and the boundary conditions constitute the complete system. A strongly coupled embedded boundary formulation is used to fully capture the fluid-structure interactions and determine the solution of the coupled system of equations. Parametric studies are undertaken to understand the dependence of the lift and drag coefficients on the relative inertia properties of the fluid and foil systems and stiffness characteristics of the flapping foil system. Instantaneous vortex dynamics is also studied, and the results obtained are compared with prior work.

[1]Research supported by the AFOSR

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Date submitted: 03 Aug 2006 Electronic form version 1.4