Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Nonlinear switched models for control of unsteady forces on a rapidly pitching airfoil[1] SCOTT DAWSON, Princeton University, STEVEN BRUNTON, University of Washington, CLARENCE ROWLEY, Princeton University — The unsteady aerodynamic forces incident on a pitching flat plate airfoil at a Reynolds number of 100 are investigated through direct numerical simulation. Linear state-space models, identified from impulse response data via the eigensystem realization algorithm, are used to accurately track rapid changes in lift coefficient through either feedback or feedforward control, even in the presence of gust disturbances. We develop a technique to project between states of linear models obtained at different angles of attack using primal and pseudo-adjoint balanced POD modes. This allows for the formation of a nonlinear switched model that is accurate over a wide range of angles of attack, in both pre- and post-stall regimes. We additionally investigate phenomena that are not captured by linear models, such as an increase in mean lift that occurs when vortex shedding frequencies are excited. The effect of changing the pitch axis is also investigated, where it is found that pitching aft of the mid-chord results in right half plane zeros that increase the difficulty of the control problem.

[1]This work was supported by AFOSR grant FA9550-12-1-0075

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Date submitted: 02 Aug 2013 Electronic form version 1.4