Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Low dimensional state-space representations for classical unsteady aerodynamic models STEVEN L. BRUNTON, CLARENCE W. ROWLEY, Princeton University — This work develops reduced order models for the unsteady aerodynamic forces on a small wing in response to agile maneuvers and gusts. In particular, the classical unsteady models of Wagner and Theodorsen are cast into a low-dimensional state-space framework. Low order state-space models are more computationally efficient than the classical formulations, and are well suited for modification with nonlinear dynamics and the application of control techniques. Reduced order models are obtained using the eigensystem realization algorithm on force data from the direct numerical simulation (DNS) of a pitching or plunging 2D flat plate at Reynolds numbers between 100 and 1000. Models are tested on rapid pitch and plunge maneuvers with a range of effective angle-of-attack. We evaluate the performance of the models based on agreement with results from DNS, in particular, the ability to reproduce lift forces over a range of pitching and plunging frequencies. Bode plots of the reduced order models, Wagner's and Theodorsen's methods, and DNS provide a concise assessment.

Steven L. Brunton
Princeton University

Date submitted: 28 Jul 2010 Electronic form version 1.4