Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

The roles of aerodynamic and inertial forces on maneuverability in flapping flight HAMID VEJDANI, DAVID BOERMA, SHARON SWARTZ, KENNETH BREUER, Brown University — We investigate the relative contributions of aerodynamic and the whole-body dynamics in generating extreme maneuvers. We developed a 3D dynamical model of a body (trunk) and two rectangular wings using a Lagrangian formulation. The trunk has 6 degrees of freedom and each wing has 4 degrees of actuation (flapping, sweeping, wing pronation/supination and wing extension/flexion) and can be massless (like insect wings) or relatively massive (like bats). To estimate aerodynamic forces, we use a blade element method; drag and lift are calculated using a quasi-steady model. We validated our model using several benchmark tests, including gliding and hovering motion. To understand the roles of aerodynamic and inertial forces, we start the investigation by constraining the wing motion to flapping and wing length extension/flexion motion. This decouples the trunk degrees of freedom and affects only roll motion. For bats' dynamics (massive wings), the model is much more maneuverable than the insect dynamics case, and the effect of inertial forces dominates the behavior of the system. The role of the aerodynamic forces increases when the wings have sweeping and flapping motion, which affects the pitching motion of the body. We also analyzed the effect of all wing motions together on the behavior of the model in the presence and in the absence of aerodynamic forces.

Kenny Breuer
Brown Univ

Date submitted: 01 Aug 2015 Electronic form version 1.4