Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Flapping counter torque (FCT) in animal flight: Experimental results and mathematical models BO CHENG, XINYAN DENG, University of Delaware — From our previous studies on a range of insects from fruit flies to cockatoos during fast yaw turning maneuvers (body saccades), we found that body rotation causes a substantial aerodynamic counter torque, termed as flapping counter-torque (FCT), which acts in the opposite direction of turning. In this study, we show that FCT exists in all roll, pitch and yaw axes and are linearly dependent on the flapping frequency and rotational velocity, respectively. We measured the FCTs systematically (by varying wing beat frequency and body turning velocity) on a pair of dynamically scaled robotic model wings. Furthermore, we developed mathematical FCT models based on quasi-steady analysis for roll, pitch and yaw axes. The results show that the experimental data matches the prediction of the analytical models. FCT induced passive damping accounts for a large part of the deceleration in saccade of animal flight, and implies passive rotational stability of the angular velocity dynamics in flapping flight.

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Date submitted: 20 Aug 2009 Electronic form version 1.4