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Aerodynamic damping during body translation in animal flight: modeling and experimental results of flapping counter force (FCF)[1] BO CHENG, ZHENG HU, XINYAN DENG — Body movements of flying animals change their effective wing kinematics and influence aerodynamic forces. Our previous studies found that substantial aerodynamic damping was produced by flapping wings during body rotation through a passive mechanism we termed flapping counter-torque (FCT). Here we present the aerodynamic damping produced by flapping wings during body translations, which we termed flapping counter-forces (FCFs). Analytical models were derived and the aerodynamic effect of spanwise flow and wing-wake interaction were also explored. The FCFs are dependent on body velocities, wing beat amplitude and frequency. Aerodynamic force and PIV measurements were compared with the analytical models. The experiments were conducted on a pair of dynamically scaled robotic model wings in an oil tank. Experiments in air using a pair of high frequency flapping wing further validate the models. Complete 6-DOF flight dynamic model was derived.

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