Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

An integrated approach on free flight mechanisms in insects and birds. HAO LIU, Chiba University/PRESTO-JST — To provide an overall understanding of aerodynamic and dynamic mechanisms in flying insects and birds we have succeed in establishing a biology-inspired dynamic flight simulator, which is capable to mimic hovering, forward flight and quick-turn on a basis of modeling of realistic geometry and wing kinematics, and modeling of wing-body flight dynamics. Coupling of an in-house CFD solver and a newly developed flapping flight dynamic solver enables the free flight simulation with consideration of both wing-wing interaction and wing-body interaction, and hence a systematic and quantitative evaluation of aerodynamics and flight stability in realistic flying animals. We carried out a systematic computational study on the hovering-and forward-flight of a wing-body moth model and validated the numerical results by comparing with the force-and moment-measurements based on a robotic moth model. Our results indicate that the leading-edge vortex is a universal high-lift/thrust enhancement mechanism in animal flight; and both aerodynamic force and inertial force are important in lift/thrust generation and power requirement, in particular in flight maneuverability.

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Date submitted: 28 Jul 2005 Electronic form version 1.4