Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

Modeling flexible flapping wings oscillating at resonance

ALEXANDER ALEXEEV, HASSAN MASOUD, Georgia Institute of Technology

— Using a hybrid approach for fluid-structure interactions that integrates the lattice Boltzmann and lattice spring models, we study the three-dimensional aerodynamics of flexible flapping wings at hovering. The wings are a pair of flat elastic plates tilted from the horizontal and driven to oscillate according to the sinusoidal law. Our simulations reveal that resonance oscillations of flexible wings dramatically increase aerodynamic lift at low Reynolds number. Comparing to otherwise identical rigid wings, flexible wings at resonance generate up to two orders of magnitude greater lift. Within the resonance band, we identify two operation regimes leading to the maximum lift and the maximum efficiency, respectively. The maximum lift occurs when the wing tip and root move with a phase lag of 90 degrees, whereas the maximum efficiency occurs at the frequency where the wing tip and root oscillate in counterphase. Our results suggest that the resonance regimes would be optimal for the design of microscale flying machines using flexible flapping wings driven by simple kinematic strokes.

Alexander Alexeev
Georgia Institute of Technology

Date submitted: 19 Nov 2009

Electronic form version 1.4