Special Program in Applied Mathematics and Applied Mechanics

生物飛行動力學

2013 - 05 - 29 (Wed.)
15:00 - 18:00
308, Mathematics Research Center Building (ori. New Math. Bldg.)

The sophisticated flight abilities of birds, bats, and insects, in particular their maneuvering agility, have long intrigued observers. Among the diverse flight modes of those creatures, hovering flight has attracted particular attention. Hovering flight signifies a sustained flight at a fixed location in mid-air. Flying insects of most species, e.g., dragonfly, drosophila, and moth, can hover well; in contrast, other than hummingbirds, only a few bird species can hover. In this work my research team investigates the influence of motion kinematics on lift production of a flapping bird-wing. Biomechanical and aerodynamic mechanisms underlying asymmetrical-hovering and ascending flights in passerines (Zosterops japonicas, Erythrura gouldiae) were experimentally and theoretically explored. In the first part of the presentation, I will introduce our research tools, which consist of the digital flow visualization techniques, the particle imaging velocimetry, the model of vortex ring for evaluating lift force, and the 3-D numerical model. Then, the quantitative visualization of the wake flow, analysis of kinematics, and evaluation of the transient lift force are revealed to dissect the biomechanics and maneuverable features of passerines in the asymmetrical hovering flight. The analysis of the ventral-clap modes, the mechanism of eye stabilization, and the flapping-flight of a small bird under the influence of the ground effect are specifically presented. In the third part, the flight mechanics of butterflies and Zygoptera as well as the propulsion mechanism of swimming fishes are studied, experimentally and theoretically, by using the similar methodology. Overall, The flight mechanisms and bio-wisdom revealed from our research on live creatures were applicable to the design of biomimetic flapping aerial-vehicles, beneficially enhancing the flight maneuverability.