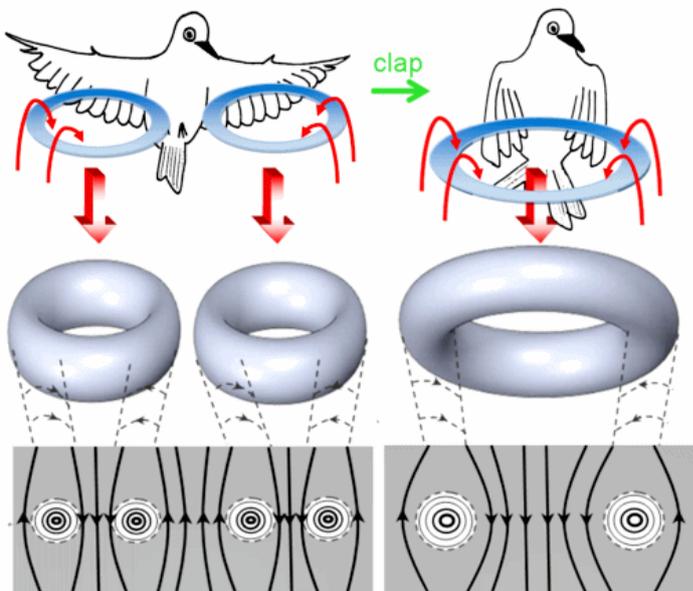


STUDY OF EYE STABILITY OF HOVERING BIRDS FEATURED IN *NATURE PHYSICS*

The findings of a research team led by Prof. Jing-tang Yang, Department of Mechanical Engineering, on how small birds hold the position of their eyes steady while hovering were featured in an article, "Aerodynamics: Bird's Eye View," by Senior Editor Andreas Tröbesinger in the "News and Views" section of *Nature Physics* (August 2011). Prof. Yang's findings were also reported in the American Physical Society's *Physics Buzz* blog in a piece titled, "How Some Birds Keep Their Eyes on the Prize" (June 2011). The findings were first reported in the article, "Aerodynamic Trick for Visual Stabilization During Downstroke in a Hovering Bird," which appeared in *Physical Review E* (DOI:10.1103/

The study points out some impressive capabilities of small birds. Hummingbirds, for instance, manage to fly backwards and sideways, while other small birds have also mastered hovering flight, with their bodies seemingly suspended in midair as they rapidly flap their wings. Prof. Yang's team identified a phenomenon that makes this feat seem even more remarkable, at least from a mechanics point of view: the most stable point of the bird's motion while hovering is not at its center of gravity but at eye level.

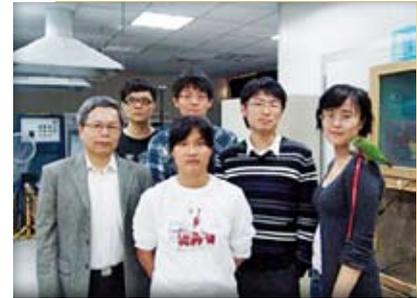
To work out how hovering birds manage to stabilize their position such that their eyes remain at the center of motion, the researchers studied a passerine bird known as the Japanese White-eye. They



These graphics show the dynamic structure of the downward air jet generated by the downstroke of the wings of the Japanese White-eye.

PhysRevE.84.012901; July 2011), a publication of the American Physical Society.

trained the birds to perform their hovering flight inside a chamber monitored by high-speed cameras, each recording 1,000 frames per second, which is fast enough to



Professor Jing-tang Yang (left) and his NTU research team show off one of their feathered friends.

finely resolve the flapping motion at around 24 Hz.

The videos reveal that the bird's body swings up and down quite substantially during hovering. The point of action of the lifting force does not, however, coincide with the center of mass of the passerine; instead, its position is slightly dorsal. The team discovered this by studying the aerodynamic mechanism of the bird's flapping. The Japanese White-eye swings up and down while hovering. During downstroke, the extended wings generate a downward air jet that pushes the bird up. However, when the wings are retracted, the bird becomes aerodynamically inactive, and the bird drops under gravity to its original position. The bird can further stabilize its head and eyes by muscular and skeletal motion. This enables it not only to keep a level head, but also to maintain a steady gaze and keep its eyes on the prize.

There is much to be learned and imitated from other creatures. Understanding the aerodynamic mechanisms that allow small birds to maintain the position of their eyes while hovering could lead to innovative applications in the development of micro aerial vehicles.