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Force production of a hovering hummingbird[1] HAOXIANG LUO, JIALEI SONG, Vanderbilt University, TYSON HEDRICK, University of North Carolina at Chapel Hill — A three-dimensional numerical study is performed for a hovering Ruby-throated hummingbird (*Archilochus colubris*) based on an immersed-boundary method. To accurately model the unsteady aerodynamics, realistic 3D wing kinematics is reconstructed from high-speed images of the wing motion filmed at 1000 frames per second, resulting in 25 frames per flapping cycle. A high-resolution grid is employed to resolve the vortices shed from the wing. The results are validated by comparing the spanwise vorticity and circulation with the previous PIV data and also by calculating the average lift. The force production shows significant asymmetry with the downstroke producing lift 2.6 times as high as the upstroke, despite a nearly horizontal stroke plane. The total power consumption is around 55 W/kg, which is twice of previous estimate. In this presentation, we will discuss several mechanisms that lead to the force asymmetry, including the drag-based lift and the leading-edge vortex behavior. We will also address the role of wing-wake interaction, which appears to be different for the hummingbird than some of the insects such as fruit flies.

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