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Wing-pitch modulation in maneuvering fruit flies is explained by an interplay between aerodynamics and a torsional spring TSEVI BEATUS, ITAI COHEN, Physics Department, Cornell University, Ithaca NY — While the wing kinematics of many flapping insects have been well characterized, understanding the underlying physiological mechanisms that determine these kinematics is still a challenge. Two of the main difficulties arise from the complexity of the interaction between a flapping wing and its own unsteady flow, as well as the intricate mechanics the insect wing-hinge, which is among the most complicated joints in the animal kingdom. These difficulties call for the application of reduced-order approaches. Here, we model the torques exerted by the wing-hinge along the wing-pitch axis of maneuvering fruit flies as a damped torsional spring with elastic and damping coefficients as well as a rest angle. Furthermore, we model the air flows using simplified quasi-static aerodynamics. Our findings suggest that flies take advantage of the passive coupling between aerodynamics and the damped torsional spring to indirectly control their wing-pitch kinematics by modulating the spring damping and elastic coefficients. These results, in conjunction with the previous literature, indicate flies can accurately control their wing-pitch kinematics on a sub-wing-beat time-scale by modulating all three effective spring parameters on longer time-scales.

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