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Flapping counter force - a unique flight stabilizing mechanism enabled by flapping wings HU DAI, HAOXIANG LUO, Vanderbilt University, XINYAN DENG, Purdue University — The flyers in nature are more sensitive to disturbances than the much-larger airplanes, and meanwhile, many of them (e.g., insects) lack the geometrical features that airplanes typically have, e.g., the vertical/horizontal tails. Therefore, a passive flight stabilizing mechanism would be of particular importance to the biological flyers, who otherwise would have to spend a great deal of effort to actively control their flight. It was recently found that insects and other flying animals possess a unique passive stabilization mechanism that stems from the coupling between their body movement and the flapping-wing motion (Hedrick, Cheng and Deng, Science, 2009). More specifically, the unsteady movement of the flyer's body in a disturbed flight modifies the effective kinematics of the wing, creating a resistant force that counteracts the body motion. In this work, we use direct numerical simulations to compute the flapping counter force associated with a two-dimensional wing, and the transient process of the disturbed body motion is also computed via flow-structure interaction. The flyer's body is represented by a lumped mass, and the flow around the wing is resolved by the simulations to accurately account for the force production mechanism. The computed force and the body transition will be compared with a quasi-steady analysis.

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