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Aerodynamic cause of the asymmetric wing deformation of insect wings[1] HAOXIANG LUO, FANGBAO TIAN, JIALEI SONG, Vanderbilt University, XI-YUN LU, USTC — Insect wings typically exhibit significant asymmetric deformation patterns, where the magnitude of deflection during upstroke is greater than during downstroke. Such a feature is beneficial for the aerodynamics since it reduces the projected wing area during upstroke and leads to less negative lift. Previously, this asymmetry has been mainly attributed to the directional bending stiffness in the wing structure, e.g., one-way hinge, or a pre-existing camber in the wing surface. In the present study, we demonstrate that the asymmetric pattern can also be caused by the asymmetric force due to the flow, while the wing structure and kinematics are symmetric. A two-dimensional translating/pitching wing in a free stream is used as the model, and the wing is represented by an elastic sheet with large displacement. The result shows that, interestingly, the wing experiences larger deformation during upstroke even though the aerodynamic force is greater during downstroke. The physical mechanism of the phenomenon can be explained by the modulating effect of the aerodynamic force on the timing of storage/release of the elastic energy in the wing.

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