Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Measurement of starting vortex strength of a hovering hawkmoth

YUN LIU, Purdue University Northwest — From the high-speed Schlieren photography, salient flow structures were successfully visualized and captured on a near hovering hawkmoth Manduca. During the down-stroke, a vortex loop was formed with evolving size and strength. Originally, optical flow method was implemented on the Schlieren images and vortical flow field was quantified at certain time instants. However, owing to the three-dimensional nature of the flow structure and its corresponding complexities, the vortical flow field quantification is not always successful and significant uncertainties in starting vortex strength estimation exists. Therefore, in this work, a further step is taken for accurately measuring the strength of starting vortex. To achieve this goal, a time resolved 2D-PIV is conducted on a hovering hawkmoth which is feeding on an artificial flower. The high-speed Schlieren photography results, on the other hand, provide us clear guidelines about how to setup the experiment and when/where to expect the starting vortex. The flow field quantification from the conventional PIV provides us reliable vortex strength data while the high-speed Schlieren photography experiments provide us critical spatial information about the three-dimensional structure of the vortex loop. With those two temporal data quantified accurately, the instantaneous aerodynamic forces can be estimated in the end.

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Date submitted: 20 Nov 2019 Electronic form version 1.4