

Applying Particle Image Velocimetry to Map Fire Ant Alate Wing Beat Induced Flows

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A particle image velocimetry (PIV) system was built at the University of Mississippi's National Center for Physical Acoustics to investigate flow fields around a flying fire ant (*Solenopsis spp.*) alate. PIV is an advanced optical method for measuring whole-field instantaneous fluid flows. Since it is extremely difficult to measure air flow around an insect at a free flight situation, the tested fire ant alate is tethered on a fine metal wire so that its body does not move during the flight. It is also necessary to put the tethered flying ant in a test chamber of proper size for reducing the influence of the environment flow. The air in the chamber is mixed with a clean fog provided by a home-made fog generator so that the air flow can be visualized with fog particles and captured with a digital imaging system. A Nd:YAG laser beam is expanded to form a light sheet in the test chamber to illuminate fog particles in a plane in the fire ant wing beat induced flow. The used laser system has a double-head configuration so that double pulses of arbitrary time interval are generated at a rate of up to 30 Hz. The used digital image system is capable of acquiring image pairs with interframing time as low as 200 ns at the same rate of the laser double pulses. The laser pulses and the image pairs are synchronized by using a precise timing box. The recording pairs of the fog particle images are evaluated with a correlation-based algorithm, to determine the particle image displacements in the image plane. The particle image displacements are converted to velocities when divided by the time interval of laser pulses and the image-to-object ratio. Because the fog particles have a very small size (i.e. a few micro meters in diameter), they follow the air flows without noticeable velocity lag, so that the velocity distribution in the light sheet plane is indirectly measured. Two sample results are given in Fig. 1.

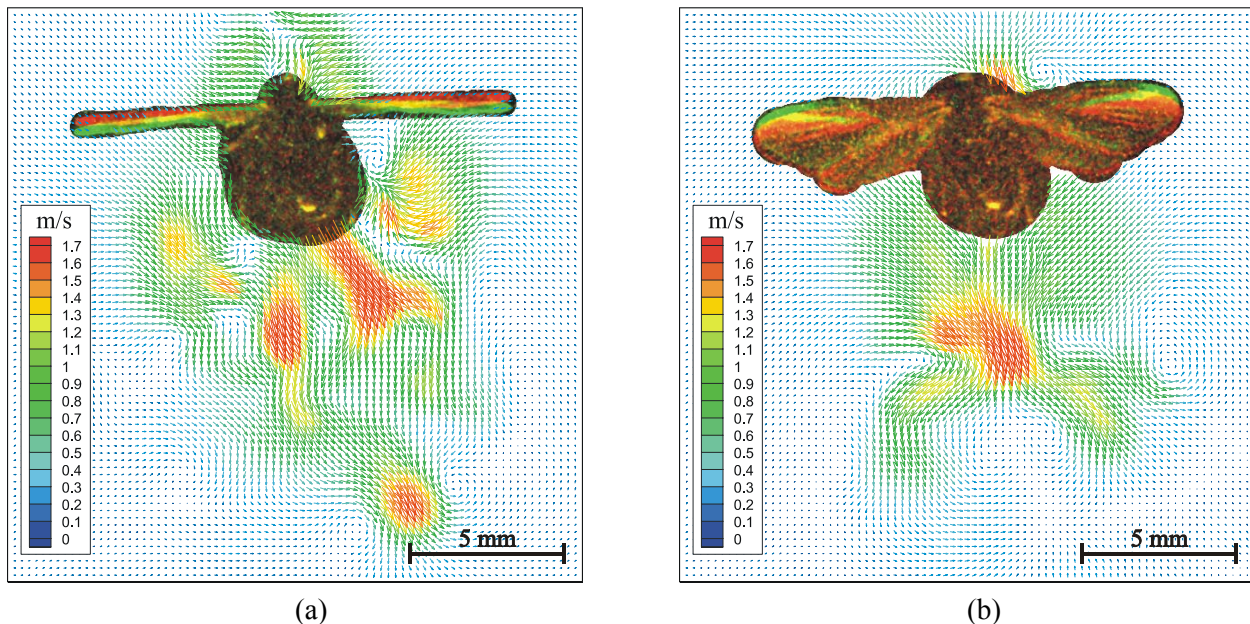


Figure 1: Sample results of fire ant alate wing beat induced flows. (a) Wings move downwards; (b) Wings move upwards.