

Abstract Submitted  
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**Lift, Drag and Flow-field Measurements around a Single-degree-of-freedom Toy Ornithopter**<sup>1</sup> RAMIRO CHAVEZ ALARCON, B.J. BALAKUMAR, JAMES ALLEN — The aerodynamics of a flight-worthy toy ornithopter under laminar inflow conditions are studied using a combination of load cell, flow visualization, high speed camera and PIV experiments. All the experiments were performed in the large wind tunnel facility at New Mexico State University, with the exception of a free flight test of the model. Measurements from a six-axis load cell were used to capture the variation of the lift and drag forces at various angles of attack, flapping frequencies and free-speed velocities. Smoke visualization is used to clearly demonstrate that the momentum flux in the downward direction during downstroke exceeds the upward momentum flux during upstroke due to the flexion of the wing and its angle of attack. This net surplus creates the lift in such ornithopter designs despite the stroke symmetry. PIV measurements are then performed at suitable locations to identify flow structures around the wing at various spanwise locations. A control volume analysis is performed to compare the momentum deficit in the wake to the load cell measurements.

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Ramiro Chavez Alarcon

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