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Aerodynamics of Unsteady Sailing Kinetics COLIN KEIL, RILEY SCHUTT, JENNIFER BORSHOFF, PHILIP ALLEY, MAXIMILIEN DE ZEGHER, CHK WILLIAMSON, Cornell University — In small sailboats, the bodyweight of the sailor is proportionately large enough to induce significant unsteady motion of the boat and sail. Sailors use a variety of kinetic techniques to create sail dynamics which can provide an increment in thrust, thereby increasing the boatspeed. In this study, we experimentally investigate the unsteady aerodynamics associated with two techniques, "upwind leech flicking" and "downwind S-turns". We explore the dynamics of an Olympic class Laser sailboat equipped with a GPS, IMU, wind sensor, and camera array, sailed expertly by a member of the US Olympic team. The velocity heading of a sailing boat is oriented at an apparent wind angle to the flow. In contrast to classic flapping propulsion, the heaving of the sail section is not perpendicular to the sail's motion through the air. This leads to heave with components parallel and perpendicular to the incident flow. The characteristic motion is recreated in a towing tank where the vortex structures generated by a representative 2-D sail section are observed using Particle Image Velocimetry and the measurement of thrust and lift forces. Amongst other results, we show that the increase in driving force, generated due to heave, is larger for greater apparent wind angles.

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