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Exploring Unsteady Sail Propulsion in Olympic Class Sailboats
RILEY SCHUTT, C.H.K. WILLIAMSON, Cornell University — Unsteady sailing techniques, defined as "flicking," "roll-tacking" and "roll-gybing" are used by athletes to propel their boats on an Olympic race course faster than using the wind alone. Body weight movements induce unsteady sail motion, increasing driving force and enhancing maneuvering performance. In this research, we explore the dynamics of an Olympic class Laser sailboat equipped with a GPS, IMU, wind sensor, and camera array. 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 (induced by the sailor's body movement) is not perpendicular to the sail's motion through the air. This leads to an "exotic 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, along with a measurement of thrust and lift forces. When combined with turning maneuvers, these heaving sail motions can lead to significant increases in velocity made good, a critical variable used when assessing racing performance.

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