

VORTEX DYNAMICS OF TURNING MANEUVERS IN OLYMPIC-CLASS SAILBOATS

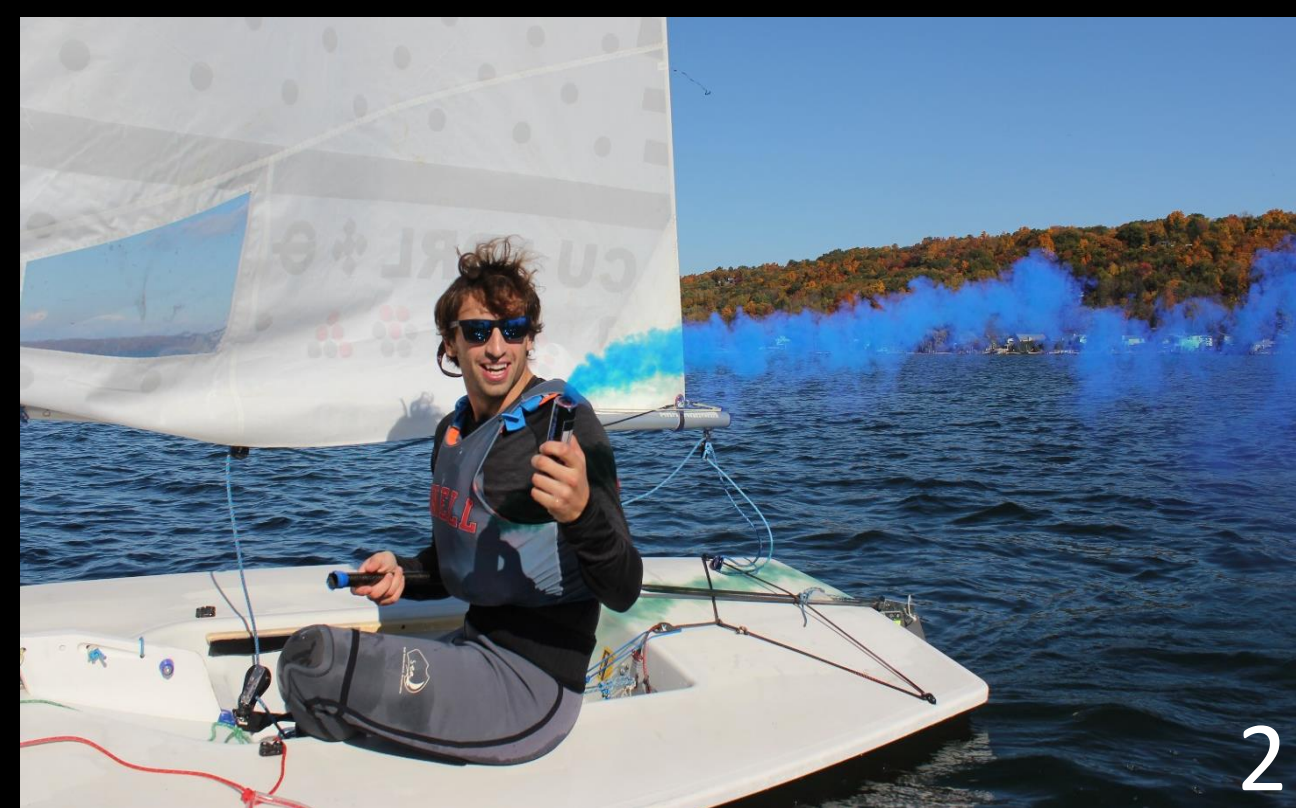
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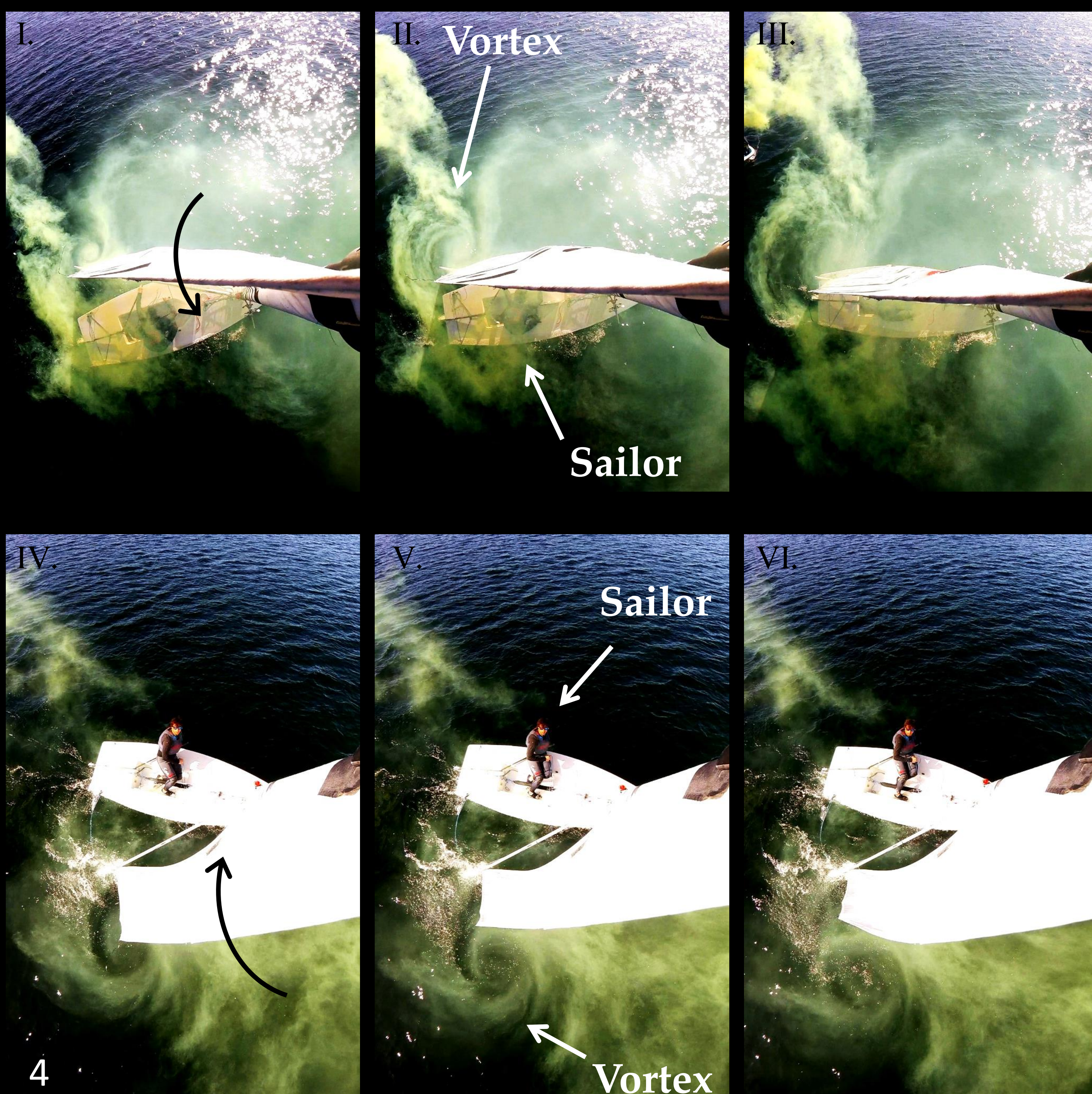
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SPORTS-INSPIRED AERODYNAMICS

A “sports-mimetic” approach is used to study the unsteady vortex dynamics of sail motion techniques, inspired by Olympic sailors as they maneuver their sailboats when racing. One such technique employed by racing sailors is to use bodyweight movements to roll the boat about its longitudinal axis. This motion is used especially when turning in light winds, by either “**roll gybing**” (downwind sailing; figure 1, 3) or “**roll tacking**” (upwind sailing). Here, we use an Olympic Class Laser Sailboat sailed by a member of the Cornell Sailing Team in Ithaca, NY, to uncover the underlying vortex dynamics associated with these techniques via full-scale smoke visualization using hand-held smoke grenades (see figure 2). As the sailor heels the boat and rolls it about its longitudinal axis, a vortex is generated on the outside side of the sail as the boom moves across the boat. The second part of this motion is the sailor flattening the boat, i.e. bringing the mast back to vertical. As this happens, a new vortex of opposite signed vorticity is generated on the new outside of the sail. The “signature” of a single **roll gybe** or a **roll tack** is a counter-rotating vortex pair. The near-sail dynamics are shown for the case of a single **roll gybe** (figure 4), and the generated counter-rotated vortex pair in the far-wake is shown for the case of a single **roll tack** (figure 5).



ROLL GYBING – NEAR-SAIL DYNAMICS



ROLL TACKING – FAR-WAKE DYNAMICS

