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Flow structure on a rotating wing undergoing deceleration to rest
DANIEL TUDBALL SMITH, Monash University, DONALD ROCKWELL, Lehigh University, JOHN SHERIDAN, Monash University — Inspired by the behavior of small biological flyers and micro aerial Vehicles, this study experimentally addresses the flow structure on a low aspect ratio rotating wing at low Reynolds number. The study focuses on a wing decelerating to rest after rotating at constant velocity. The wing was set to a constant 45° angle of attack and, during the initial phase of the motion, accelerated to a constant velocity at its radius of gyration, which resulted in a Reynolds number of 1400 based on the chord length. Stereoscopic PIV was used to construct phase-averaged three-dimensional (volumetric) velocity fields that develop and relax throughout the deceleration and cessation of the wing motion. During gradual deceleration, the flow structure is maintained when normalised by the instantaneous velocity; the distinguishing feature is shedding of a trailing edge vortex that develops due to the deceleration. At higher deceleration rates to rest, the flow structure quickly degrades. Induced flow in the upstream direction along the surface of the wing causes detachment of the previously stable leading edge vortex; simultaneously, a trailing-edge vortex and the reoriented tip vortex form a co-rotating vortex pair, drawing flow downward away from the wing.

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