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Lagrangian coherent structure analysis in the three-dimensional wake of a bio-inspired trapezoidal pitching panel[1] RAJEEV KUMAR, JUSTIN KING, MELISSA GREEN, Syracuse Univ — Three-dimensional Lagrangian analysis using the finite-time Lyapunov exponent (FTLE) field has been carried out on experimentally captured wake downstream of an oscillating trapezoidal panel. The trapezoidal geometry of the panel served as a simple model of a fish caudal fin. Three-dimensional FTLE isosurface appears as a shell wrapped around the wake vortex structures. A slice through the isosurfaces results in the familiar two-dimensional FTLE ridges. The attracting ridges (nFTLE) and the repelling ridges (pFTLE) are near-material lines and their intersections are analogous to topological saddle points in the flow field. A vortex-ring-based wake structure induces a streamwise momentum jet, evolution of which appears to be related to the timing of saddle point generation and behavior at the trailing edge. The time of release of these saddles at the trailing edge inside a pitching period appears to coincide with thrust extrema in similar experimental and numerical studies on foils and fins published in the literature. The merger of a pair of saddles from two consecutively shed vortices at a downstream location coincides with the occurrence of wake breakdown and precedes the formation of interconnected vortex loops and beginning of momentum-deficit zone in the time-averaged sense.

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