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What do fishes and fighter jets have in common?[1] DANIEL QUINN, QIANG ZHONG, HAIBO DONG, University of Virginia, SMART FLUID SYSTEMS TEAM — Multi-fin systems, like fish or fish-inspired vehicles, are governed by unsteady three-dimensional interactions between their multiple fins. In particular, dorsal/anal fins have received much attention because they are just upstream of the main thrust-producing fin: the caudal (tail) fin. We used a tuna-inspired fish model with variable fin sharpness to study the interaction between elongated dorsal/anal fins and caudal fins. We found that the performance enhancement is stronger than previously thought (15% increase in swimming speed and 50% increase in swimming economy) and is governed by a three-dimensional Dorsal Fin-induced Crossflow that lowers the angle of attack on the caudal fin and promotes spanwise flow. Both simulations and multi-layer Particle Image Velocimetry reveal that the crossflow stabilizes the Leading Edge Vortex on the caudal fin, similar to how wing strakes prevent stall during fixed-wing aircraft maneuvers. Unlike other fin-fin interactions, this mechanism is phase-insensitive and offers a simple, passive solution for flow control over oscillating propulsors. Our results offer new insights into dorsal/anal fin shape and placement in fish and fish-inspired vehicles.

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