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Propulsive effects of vortex coupling between parallel pulsed jets[1]

ATHANASIOS ATHANASSIADIS, DOUGLAS HART, Massachusetts Inst of Tech-MIT — For vehicles that use pulsed jet propulsion, nature provides inspiration for different ways to improve propulsive performance. Communities of marine invertebrates called salps improve the efficiency of cruising locomotion by aggregating into large multi-animal chains. In this process, the cylindrical animals physically connect to each other side-by-side to form an array of individual pulsed jets whose synchronous pulsing propels the entire chain forward. Some benefits of this chaining behavior can be described using existing models of pulsed jet propulsion for steady, cruising conditions. However, during unsteady conditions such as impulsive maneuvering at low speeds, it remains unclear how interactions between neighboring jets will affect the chain's propulsive performance. Using bench-top experiments, we investigate the unsteady interactions between two parallel pulsed jets. Under some conditions, the pulsed jets form vortex rings that coalesce before vortex formation is complete, coupling the hydrodynamics of the independent jets. We measure how different degrees of vortex coupling alter the energy and momentum transfer in the two-jet system. Finally, we explore the energy and momentum scalings that would guide the design of a vehicle using multi-jet maneuvering techniques.

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