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In-phase vs. out-of-phase synchronization in side-by-side swimmers[1] RAMIRO GODOY-DIANA, JÉRÔME VACHER, VERONICA RASPA[2], BENJAMIN THIRIA, Physique et Mécanique des Milieux Hétérogènes (PMMH), CNRS, ESPCI Paris, Univ. PSL, Sorbonne Univ., Univ. de Paris, France
— In-phase and out-of-phase synchronization of neighboring swimmers is examined experimentally using two self-propelled independent flexible foils swimming side-by-side in a water tank. The foils are actuated by pitching oscillations at one extremity—the head of the swimmers—and the flow engendered by their undulations is analyzed using two-dimensional particle image velocimetry in their frontal symmetry plane. Following recent observations on the behavior of real fish, we focus on the comparison between in-phase and out-of-phase actuation by fixing all other geometric and kinematic parameters. We show that the advantage of out-of-phase synchronization in terms of swimming performance for the two-foil "school" results from the emergence of a periodic coherent jet between the two swimmers. We quantify the associated increase in impulse transfer to the fluid and the minimization of transverse mixing.

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