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Bistable synchronization modes in hydrodynamically coupled micro-rotors HANLIANG GUO, ANUP KANALE, University of Southern California, SEBASTIAN FUERTHAUER, Center for Computational Biology, Simons Foundation, EVA KANSO, University of Southern California; Center for Computational Biology, Simons Foundation — Cilia often beat in synchrony, and they may transition between different synchronization modes in the same cell type. For example, cilia in the mammalian brain ventricles are reported to periodically change their collective beat orientation, providing a cilia-based switch for redirecting the transport of cerebrospinal fluid. Experimental and theoretical evidences suggest that phase coordinations can be achieved solely via hydrodynamical interactions. However, the exact mechanisms responsible for transitioning between various synchronization modes remain illusive. Here, we use a theoretical model where each cilium is represented by a bead moving along a closed trajectory close to a no-slip surface. We investigate the emergent synchronization modes and their stability for various cilia-inspired force profiles. We observe distinct stable synchronization modes between two rotors, including a bistable regime where both in-phase and anti-phase synchronizations are stable. We then extend this analysis to an array of rotors where we demonstrate the dynamical formations of metachronal waves. These findings may help us to understand the origin of synchrony in biological and bio-inspired systems, and the mechanisms underlying transitions between different synchronization modes.

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