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Symmetry breaking in hydrodynamically-coupled microfilaments
YI MAN, EVA KANSO, Univ of Southern California — Biological microfilaments exhibit a variety of synchronization modes. Recent experiments revealed that a pair of isolated eukaryotic flagella, coupled solely via the fluid medium, display synchronization with different phase lags. Using an elasto-hydrodynamic filament model in conjunction with numerical simulations and a Floquet-type theoretical analysis, we showed that it is possible to reach synchronization states with multiple phase lags by varying the intrinsic activity of the filament and the strength of hydrodynamic coupling between the two filaments. In particular we found that non-trivial phase lag corresponds to asymmetric synchronization even though the activity of the two filaments is identical. We then derived an evolution equation for the phase difference between the two filaments at weak coupling, and used a Kuramoto-style phase sensitivity analysis to reveal the nature of the bifurcations underlying the transitions between these different synchronized states. Lastly, we analyzed the total hydrodynamic force on the coupled filaments and found that the total propulsive force depends on the filament activity but is independent of the synchronization modes, which could have significant implications in the locomotion of bi-flagellated cells.

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