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In-line and cross-flow multi-frequency vortex-induced vibrations of a long flexible cylinder are phase-locked under wake-body synchronization REMI BOURGUET, IMFT - CNRS, GEORGE KARNIADAKIS, Brown University, MICHAEL TRIANTAFYLLOU, MIT — A slender flexible body with bluff cross-section immersed in cross-flow exhibits vortex-induced vibrations. The vibrations are excited by the flow under a condition of lock-in defined as the synchronization between vortex formation and body displacement. Within a sheared current, the possible occurrence of the lock-in condition at a number of different locations can lead to broadband vibrations involving a wide range of excited frequencies and structural wavenumbers. In a previous study focusing on the vortex-induced vibrations of a flexible cylinder at a single frequency in each direction, we have found that the lock-in condition is established through counter-clockwise figure-eight trajectories where the body moves upstream at the extremes of the cross-flow oscillation. In the present work, on the basis of direct numerical simulation results, we show that this mechanism can be generalized to multi-frequency responses: even if the trajectory shape substantially departs from a figure eight, the phase difference between the components of the in-line and cross-flow vibrations locally involved in the lock-in phenomenon remains within a particular range, associated with counter-clockwise figure-eight orbits in the mono-frequency case.

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