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Phase-based analysis of synchronization between laminar cylinder wake and external harmonic actuations[1] MOHAMMAD AMIN KHODKAR, KUNIHIKO TAIRA, UCLA — We leverage phase-reduction theory to explore the synchronization properties of the two-dimensional periodic flow over a circular cylinder at Reynolds number of 100. Towards this end, a direct method based on applying weak impulse perturbations at various locations in the near wake and at several times over a period is adopted. The phase response of the wake flow to these impulses reveals how its dynamics can be impacted by external periodic actuations, through enabling the development of a one-dimensional and linear phase-based model with respect to the limit cycle, in place of the full high-dimensional and nonlinear dynamics of the wake. Comparison between the results of the current work and those provided by the Koopman- or adjoint-based analysis of the flow illustrates the commonalities and differences between these methods, while highlighting the characteristic features and capabilities of the phase-reduction analysis. The excellent predictions of the present model with regard to the synchronization properties of the flow under consideration holds promise for its application to complex engineering problems such as structural vibrations and biological swimmers and flyers.

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