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Analysis of Local Flow Dynamics Using Koopman Modes[1]
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— The Koopman operator is a linear operator defined for any dynamical system, be it linear or nonlinear. The corresponding Koopman modes, which can be computed using an Arnoldi-like algorithm called Dynamic Mode Decomposition (DMD), provide a means of identifying structures relevant to the local dynamics. Each mode is associated with a distinct frequency, unlike those resulting from Proper Orthogonal Decomposition (POD). Here we present a Koopman analysis of the flow past a 2-D cylinder. Using this single approach, we are able to identify modes relevant to the linearized (near-equilibrium), transient, and limit cycle (periodic shedding) dynamics. We also present a preliminary analysis of a high Reynolds number, separated flow past a flat plate with an elliptical leading edge. Koopman analysis confirms the observation that such flows are dominated by a small set of natural frequencies. The corresponding Koopman modes display familiar physical features.

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