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Applications of Koopman Operator Theory to Model Reduction in Fluid Mechanics HASSAN ARBABI, IGOR MEZIĆ, University of California, Santa Barbara — We discuss some applications of the Koopman operator theory to the problems in fluid mechanics. These applications involve the Koopman mode decomposition (KMD), which describes the nonlinear evolution of the flow field observables, such as velocity or vorticity field, in terms of a linear expansion - analogous to the normal mode analysis in linear oscillations. By applying KMD to the incompressible flow in a 2D rectangular cavity, we identify the spectrum of the flow with the associated global modes, both in periodic and aperiodic regime. We also apply KMD to in-vivo measurements of the blood velocity field inside human's heart, and extract the Koopman modes and frequencies based on the assumption of evolution on an attractor. The dominant Koopman modes are then combined to create a low-dimensional model for both the cavity and heart flow. The mesochronic analysis shows that those reduced models capture the mixing topology with an accuracy comparable to that of the original data. Comparison in the L^2-norm also shows that the reduced models obtained by KMD could give a more accurate representation of the flow field compared to POD.

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