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Using Persistent Homology to Compare Chaotic Dynamics Between Experiments on and Simulations of Rayleigh-Bénard Convection[1]

BRETT TREGONING, Georgia Institute of Technology, SAIKAT MUKHERJEE, Virginia Polytechnic Institute and State University, RACHEL LEVANGER, University of Pennsylvania, MU XU, Columbia University, JACEK CYRANKA, University of California San Diego, KONSTANTIN MISCHAIKOW, Rutgers University, MARK PAUL, Virginia Polytechnic Institute and State University, MICHAEL SCHATZ, Georgia Institute of Technology — Persistent homology is a tool from algebraic topology that can be used to efficiently detect pattern features in image data. In the spatio-temporally chaotic flow known as spiral defect chaos in Rayleigh-Bénard convection, we explore the use of pattern features detected by persistent homology as a proxy for fundamental dynamical quantities that are not observable in experimental data but can be calculated from simulations, such as leading-order Lyapunov vectors. In simulations, we have identified that convective plumes are highly correlated with the leading-order Lyapunov vectors; however, we find that plumes appear in experiments at distinctly different rates than for Boussinesq simulations at the same parameter values. We describe work to resolve this discrepancy by accounting for non-Boussinesq effects in both experiments and simulations.

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