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Describing Chaotic Dynamics in Rayleigh-Benard Convection Using Persistent Homology Theory[1] JEFFREY TITHOF, MICHAEL SCHATZ, Center for Nonlinear Science and School of Physics, Georgia Institute of Technology, KONSTANTIN MISCHAIKOW, MIROSLAV KRAMAR, VIDIT NANDA, Department of Mathematics, Rutgers University, MARK PAUL, MU XU, Department of Mechanical Engineering, Virginia Polytechnic Institute and State University — We present a new technique for describing the dynamics of spatio-temporal chaos in Rayleigh-Benard convection (RBC). Developed as a tool in algebraic topology, persistent homology theory provides a powerful mathematical formalism for describing the time evolution of geometrical objects. This is done by encoding their topological characteristics in a so-called persistence diagram. When applied to shadowgraph images of spiral defect chaos in RBC, different flow structures correspond to unique features in the persistence diagram. Use of these diagrams helps us to understand the dynamical connections between RBC states, complementing the traditional techniques used in pattern recognition.

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