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Using Persistent Homology to Identify Localised Defects in Rayleigh Bénard Convection[1] BALACHANDRA SURI, JEFFREY TITHOF, MICHAEL SCHATZ, Georgia Institute of Technology, RACHEL LEVANGER, JACEK CYRANKA, KONSTANTIN MISCHAIKOW, Rutgers University, MU XU, MARK PAUL, Virginia Institute of Technology, MIROSLAV KRAMAR, AIMR Tohoku UNiversity — Complex spatiotemporal convective roll patterns are observed when a sufficiently large temperature gradient is created across a thin layer of fluid. These roll patterns are often characterized by the presence of localised defects such as centers, spirals, disclinations, grain boundaries, which play a crucial dynamical role. Our research focuses on using persistent homology (a branch of algebraic topology) to identify these defects in an experimental realization of the Rayleigh Bénard convection in a cylindrical container. Persistent homology provides a powerful mathematical formalism in which the topological characteristics of a pattern (shadowgraph image in our case) are encoded in a so-called persistence diagram. By identifying several instants in the experiment that correspond to the appearance of a certain type of defect and computing the persistence diagrams for the corresponding shadowgraph images, we extract signatures in the persistence diagram which characterize the defect. Then, for a spatiotemporally resolved series of shadowgraph images we show that using signatures from the persistence diagrams one can automate identifying the instants when localized defects appear.

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