Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Topological equivalence between 3D buoyancy-driven and lid-driven cavity flows[1] SEBASTIAN CONTRERAS, Eindhoven University of Technology, IMAN ATAEI, Delft University of Technology, MICHEL SPEETJENS, Eindhoven University of Technology, CHRIS KLEIJN, MARK TUMMERS, Delft University of Technology, HERMAN CLERCX, Eindhoven University of Technology — The present study concerns Lagrangian transport and (chaotic) advection in three-dimensional (3D) flows in cavities under steady and laminar conditions. The main goal is to investigate topological equivalences in 3D streamline patterns and their response to nonlinear effects between flow classes driven by different forcing. To this end we consider two classical systems that are important in both natural and industrial applications: a buoyancy-driven flow (laterally-heated configuration) and a lid-driven flow governed by the Grashof (Gr) and the Reynolds (Re) numbers, respectively. Symmetries imply fundamental similarities between the streamline patterns of these flows. Moreover, nonlinearities induced by buoyancy (increasing Gr) in the buoyancy-driven flow versus fluid inertia (increasing Re) and forcing protocol in the lid-driven flow cause similar bifurcations of the flow topology. These analogies imply that Lagrangian transport is governed by universal mechanisms and differences are restricted to the manner in which these phenomena are triggered. Experimental validation of key aspects of the Lagrangian dynamics is carried out by particle image velocimetry and 3D particle-tracking velocimetry.

[1]S.C. acknowledges financial support from CONACYT Mexico.

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Date submitted: 29 Jul 2019 Electronic form version 1.4