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Lagrangian transport in a class of three-dimensional buoyancy-driven flows[1] SEBASTIAN CONTRERAS, MICHEL SPEETJENS, HERMAN CLERCX, Eindhoven University of Technology — The study concerns the Lagrangian dynamics of three-dimensional (3D) buoyancy-driven cavity flows under steady and laminar conditions due to a global temperature gradient imposed via an opposite hot and cold sidewall. This serves as archetypal configuration for natural-convection flows in which gravity is perpendicular to the global temperature gradient. Limited insight into the Lagrangian properties of this class of flows motivates this study. The 3D Lagrangian dynamics are investigated in terms of the generic structure of the Lagrangian flow topology that is described in terms of the Grashof number (Gr) and the Prandtl number (Pr). Gr is the principal control parameter for the flow topology: vanishing Gr yields a state of closed streamlines (integrable state); increasing Gr causes the formation of toroidal coherent structures embedded in chaotic streamlines governed by Hamiltonian mechanisms. Fluid inertia prevails for "smaller" Gr. A buoyancy-induced bifurcation of the flow topology occurs for "larger" Gr and underlies the emergence of "secondary rolls" and secondary tori for "larger" Pr. Stagnation points and corresponding manifold interactions are key to the dynamics.

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