Abstract Submitted
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Lagrangian transport characteristics of a class of three-dimensional inline-mixing flows with fluid inertia[1] MICHEL SPEETJENS, ESUBALEW DEMISSIE, Eindhoven Univ of Tech, GUY METCALFE, CSIRO Materials Science & Engineering, HERMAN CLERCX, Eindhoven Univ of Tech — Laminar inline mixing is key to many industrial systems. However, insight into fundamental transport phenomena in case of 3D conditions and fluid inertia remains limited. This is studied for inline mixers with a cylindrical geometry. Said effects introduce three key features absent in simplified configurations: smooth transition between mixing cells; local upstream flow; symmetry breaking. Topological considerations imply a net throughflow region strictly separated from possible internal regions. The Lagrangian dynamics in this region admits representation by a 2D time-periodic Hamiltonian system. This establishes one fundamental kinematic structure for the present class of inline-mixing flows and implies universal behavior. All states follow from Hamiltonian breakdown of one common integrable state. Period-doubling bifurcation is the only way to eliminate transport barriers originating from the integrable state and thus necessary for global chaos. Important in a practical context is that a common simplification, i.e. cell-wise developed Stokes flow, retains these fundamental kinematic properties and deviates from the 3D inertial case essentially only in a quantitative sense. This substantiates its suitability for (at least first exploratory) studies on mixing properties.

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