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Eigenmode analysis of advective-diffusive transport in micromixers by the diffusive mapping method PATRICK ANDERSON, MICHEL SPEETJENS, OLEKSANDR GORODETSKYI, TU Eindhoven, MAX GIONA, Sapienza, MIXING COLLABORATION — Advective-diffusive transport in microflows is studied by means of the diffusive map- ping method, a recent extension of the mapping method by Gorodetskyi et al. (Phys. Fluids 24, 2012) that includes molecular diffusion. This greatly expands the application area of the mapping technique and makes the powerful concepts of eigenmode decompo- sition and spectral analysis of scalar transport accessible to an important class of flows: inline micromixers with diffusion. The staggered herringbone micro-mixer is adopted as a prototypical three-dimensional micro mixer. Simulations with the diffusive mapping method are in close agreement with experimental observations in literature and expose a strong impact of diffusion on the transport. Diffusion enables crossing of Lagrangian trans- port barriers and thus smoothens concentration gradients and accelerates homogenization. Spectral analysis of the mapping matrix reveals this already occurs on a modal level in that individual eigenmodes progressively smoothen and spread out across transport bar- riers with stronger diffusion. Concurrently, the corresponding eigenvalues diminish and thus fundamentally alter the mixing process by invariably causing homogenization, irre- spective of the Lagrangian flow structure. This happens faster and exhibits an earlier emergence of the dominant eigenmode the stronger the diffusion. Lagrangian structures may still affect the spectral properties in that flows comprising both islands and chaotic seas typically result in a richer set of eigenmodes compared to cases with global chaos.

Patrick Anderson
TU Eindhoven

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