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Deducing global mixing information in the heart from sparse particle trajectory data GIUSEPPE DI LABBIO, Polytechnique Montreal, JEAN-LUC THIFFEAULT, University of Wisconsin - Madison, LYES KADEM, Concordia University Montreal — Ineffective or vigorous mixing in the heart, particularly in the left ventricle (LV), has been associated with several adverse cardiovascular events. Over the years, this poor mixing behavior has largely been quantified using particle residence times, shear stress accumulations and finite-time Lyapunov exponents. Unfortunately, these measures are often impractical to clinicians as they require specialized knowledge as well as relatively high spatiotemporal resolutions and computational costs. In this work, we demonstrate how sparse particle trajectory data can be used to deduce a minimal global description of the mixing behavior in the LV. By inspecting the properties of mathematical braids formed by entangled random particle trajectories, three such descriptive properties can be obtained: 1) whether the mixing process has a preferred rotational direction; 2) how well it engages dispersed material elements (avoiding stagnant regions); 3) its energetic complexity or quality. We illustrate the intuitiveness of the braid approach in understanding the mixing behavior in left ventricular flows (using chronic aortic regurgitation datasets for demonstration) and recommend further investigations for the diagnosis of diseases, monitoring disease progression and evaluating medical devices.

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