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Characterization of Left Atrial Flow Patterns by Proper Orthogonal Decomposition in Universal Atrial Coordinates

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Atrial fibrillation (AF), the most common arrhythmia, disturbs the normal flow pattern inside the left atrium (LA), leading to increased thrombosis risk within the left atrial appendage (LAA). Clots formed within the LAA can travel to the brain, causing stroke. Despite significant recent advances, the characterization of LA physiological and pathological flow patterns is hampered by the complexity and variability in LA anatomy, making it difficult to generalize and compare flow data across different patients and flow regimes (*i.e.*, sinus rhythm vs. AF).

This work aims to develop a computational framework for an objective, quantitative characterization of patient-specific flow patterns in the LA. Our approach is based on dimensionality reduction of hemodynamic variables by modal decomposition. To facilitate the analysis, we project the flow fields in the Universal Atrial Coordinate (UAC) system developed by Roney et al. [1], which maps atrial anatomy to the unit square employing two coordinates and a few landmark points.

To show proof of concept of this approach, we perform proper orthogonal decomposition (POD) of LA flow fields obtained by computational fluid dynamics simulations in patient-specific anatomies obtained by 4D-CT [2]. The analysis provides the characteristic LA flow patterns in with patients with normal atrial function, impaired atrial function. It also illustrates the flow features associated with LAA thrombus formation.

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