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Chaotic Advection and Mixing in Pulsed Source-Sink Systems

Mark A. Stremler, Baratunde A. Cola

Department of Mechanical Engineering, Vanderbilt University, Nashville, USA

It is well-known that pulsing a source and a sink in the unbounded plane can produce chaotic advection. This knowledge provides motivation for mixing laminar flows in high-aspect-ratio volumes using an arrangement of sources and sinks. In contrast to the existing chaotic advection analysis, the actual system is bounded and the sources and sinks must operate in pairs in order to conserve volume. These are substantial changes that impact the extent and character of the chaos. Fortunately, analytic solutions exist for source-sink pairs in unbounded and various bounded domains. We will present the results of a chaotic advection analysis that identifies the optimal operating parameters for producing chaos in pulsed source-sink systems in unbounded, circular, and rectangular domains. Application of this approach to DNA microarray analysis demonstrates that a pulsed source-sink system can significantly enhance transport and mixing in high-aspect-ratio volumes.

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