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Lagrangian Coherent Structures: Introduction and Applications

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Lagrangian Coherent Structures (LCS) are distinguished material surfaces that organize the global mixing and transport of fluid particles. While these surfaces define a skeleton that governs all mixing events even in turbulent flows, LCS remain hidden to traditional coherent structure detecting methods based on vorticity, pressure, streamlines, or other frame-dependent quantities. Here we review the mathematical foundations of LCS and discuss how they can be located in an objective (frame-independent) way in complex flows. We also highlight applications to experimental and numerical flow data analysis. Examples include two-dimensional rotating turbulence, hairpin vortices in three-dimensional numerical simulations, passive ocean pollution control and atmospheric clear-air turbulence detection. Some of these examples will be discussed in more detail in later talks within this minisymposium.