An introduction to Lagrangian Coherent Structures

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In the past 20 years, in the area of Dynamical Systems, there has been a strong interest on the development of mathematical tools to be able to detect, or even to predict, the structure of complex physical phaenomena involving fluid flows. Examples include blood flow, pollution control strategies in the ocean and many more. Lagrangian Coherent Structures (LCS) emerged and have been formally defined exactly from this need. Although many definitions of LCSs are possible, in this seminar we are going to follow the paper of Shawn C. Shadden, Francois Lekien and Jerrold E. Marsden below cited, which presents a formal introduction to LCS via finite-time Lyapunov exponents. Furthermore we will be able to, at least intuitively, arrive at the main result of the paper: the flux through a LCS is negligible, for well-defined LCSs.

References

(1) T.Peacock, John Dabiri, Introduction to Focus Issue: Lagrangian Coherent Structures, 2010 American Institute of Physics

(2) S. Shadden, F. Lekien, J.E. Marsden, Definition and properties of Lagrangian coherent structures from finite-time Lyapunov exponents in two-dimensional aperiodic flows, Physica D 212 (2005) 271-304

(3) G. Haller, Lagrangian Coherent Structures, Annual Review of Fluid Mechanics, 2014

(4) A.Hadjighasem, M. Farazmand, D. Blazevski, G. Froyland, G.Haller, A Critical Comparison of Lagrangian Methods for Coherent Structure Detection

(5) G. Haller, Finding finite-time invariant manifolds in two-dimensional velocity fields