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Evolution of Lagrangian structures in the K-type temporal transition in channel flow YAOMIN ZHAO, YUE YANG, SHIYI CHEN, State Key Laboratory for Turbulence and Complex Systems, Peking University — We report a Lagrangian study on the evolution of hairpin vortices in the K-type temporal transition in a channel flow. Based on the Eulerian velocity field from the direct numerical simulation, a backward-particle-tracking method is used to solve the Lagrangian scalar transport equation, and Lagrangian material surfaces are extracted as isosurfaces of the Lagrangian scalar. As an approximation of the Helmholtz vorticity theorem, a Lagrangian surface, which is initially a vortex surface, can be approximately as a vortex surface before significant vortex reconnections in a time evolution (Yang and Pullin, J. Fluid. Mech., 2010). Thus, by tracking the evolution of Lagrangian material surfaces in the early transitional phase, the dynamics of hairpin vortices can be studied in a Lagrangian framework. In the present study, the Lagrangian surface evolves from a streamwise-spanwise vortex sheet to a Λ-shaped bulge, and then rolls up into a hairpin-shaped structure. The dynamical evolution of the Lagrangian hairpin vortex is analysed in consecutive times. With the comparison of the coherent structures identified by the Eulerian criteria (e.g., 'λ_2-criterion'), differences between Lagrangian and Eulerian structures are discussed.

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