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Formation of chaotic packets of hairpin vortices in a channel flow
KYOUNGYOUN KIM, HYUNG JIN SUNG, Korea Advanced Institute of Science and Technology, RONALD J. ADRIAN, Arizona State University — We examine the auto-generation mechanism by which new hairpin vortices are created from sufficiently strong hairpin and they form into a packet. Emphasis is placed on the effects of initial small background noise on the packet formation. The initial conditions are given by conditionally averaged flow fields associated with Q2 event in the fully turbulent channel flow DNS database at $Re_\tau = 395$. A small amount of noise is added to the initial field. The nonlinear evolution of the initial vortical structure is tracked by performing a spectral simulation. The initial background noise leads to chaotic development of hairpin packet. The hairpins become asymmetric, leading to much more complicated packet structures than a symmetric hairpin vortex train of the clean background. However, the chaotic packets show the same properties as the clean packet in terms of the growth rate of vertical and spanwise dimensions and the distance between successive vortices. This suggests that the auto-generation mechanism is robust. Conditionally averaged flow fields around tall attached vortices in the hairpin packet show a 'downstream wake' structure of low momentum fluids, which is consistent with the fully turbulent DNS results of Del Alamo et al. [J. Fluid Mech. 561, p.329 (2006)].

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