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Study of very-large-scale motions in turbulent pipe flow[1] JAE HWA LEE, HYUNG JIN SUNG, KAIST — Direct numerical simulation (DNS) of turbulent pipe flow was performed at Re_τ=544 to investigate the spatial organization of the very large-scale motions (VLSMs). The streamwise domain length employed here was $30R$, where R is the pipe radius. Inspection of the three-dimensional instantaneous fields showed that adjacent large-scale packet-like structures combine to form the VLSMs, and this formation process was attributed to continuous stretching of the hairpins coupled with lifting-up and backward curling of the vortices. To support our results found in the analysis of the instantaneous flow fields, we applied the spatial filter to decompose the signal into two length scales related to the VLSMs and smaller structures. The resulting streamwise length scale from the streamwise two-point correlations showed that the magnitude of the correlations for the VLSMs is larger than that from the large-scale motions (LSMs) through all directions. In addition, the mean inclination angle to the wall for the smaller scale structures was found to be larger than that of the VLSMs. These findings support the previous conjecture of Kim & Adrian (1999) that the coherent alignment of LSMs creates the VLSMs.

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