

Abstract Submitted
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Streak instability as an initiating mechanism of the large-scale motions in a turbulent channel flow. MATTEO DE GIOVANETTI, Department of Aeronautics, Imperial College London, HYUNG JIN SUNG, Department of Mechanical Engineering, KAIST, YONGYUN HWANG, Department of Aeronautics, Imperial College London — The large-scale motions (or bulges) have often been believed to be formed via merge and/or growth of the near-wall hairpin vortical structures. Here, we report our observation that they can be directly generated by an instability of the amplified streaky motions in the outer region (i.e. very-large-scale motions) through the self-sustaining process. We design a LES-based numerical experiment in turbulent channel flow for $Re_\tau = 2000$ where a body forcing is implemented to artificially drive an infinitely long streaky motion in the outer layer. As the forcing amplitude is increased, it is found that a new energetic structure emerges at $\lambda_x \approx 3 \sim 4h$ of the streamwise length (h is the half height of channel) particularly in the wall-normal and spanwise velocities. A careful statistical examination reveals that this structure is likely to be linked with the sinuous-mode streak instability of the amplified streak, consistent with previous theoretical studies. Application of dynamic mode decomposition to this instability further shows that the phase speed of this structure scales with the outer velocity and it is initiated around the critical layer of the streaky flow.

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