Contribution ID: **22** Type: **not specified**

Condensate in quasi-two-dimensional turbulence

Wednesday, 11 December 2019 16:00 (15 minutes)

We investigate the process of formation of large-scale structures in a turbulent flow confined in a thin layer. By means of direct numerical simulations of the Navier-Stokes equations, forced at an intermediate scale, we obtain a split of the energy cascade in which one fraction of the input goes to small scales generating the three-dimensional direct cascade. The remaining energy flows to large scales producing the inverse cascade which eventually causes the formation of a quasi-two-dimensional condensed state at the largest horizontal scale. Our results show that the connection between the two actors of the split energy cascade in thin layers is tighter than what was established before: the small-scale three-dimensional turbulence acts as an effective viscosity and dissipates the large-scale energy thus providing a viscosity-independent mechanism for arresting the growth of the condensate. This scenario is supported by quantitative predictions of the saturation energy in the condensate.

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Session Classification: Session 3