Influence of the Vorticity Quasi-Shocks on the Direct Cascade in Two-Dimensional Turbulence

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This paper is the extension of the previous papers [1] devoted to investigations of the direct cascade in two-dimensional decaying turbulence at high Reynolds number. The numerical simulations with the better spatial resolution (up to 8192x8192 grid points) have confirmed the main previous results obtained in [1]. In particular, we have observed direct cascade of the Kraichnan type with fall-off k^{-3}-spectrum. By means of the spatial filtering we have verified that this spectrum is appeared due to the formation of sharp vorticity gradients which we call the vorticity quasi-shocks. We have observed also the strong angular dependence of the spectrum appearing due to a set of jets with a weak and/or strong overlapping. The structure function of third order shows a good correspondence to the Kraichnan direct cascade picture with the constant enstrophy flux. Powers ζ_n for higher structure functions grow weaker the linear dependence relative to n, demonstrating the intermittency property.

References

[1] E.A. Kuznetsov, V. Naulin, A.H. Nielsen, and J.J. Rasmussen, Effects of sharp vorticity gradients in two-dimensional hydrodynamic turbulence, Phys Fluids 19, 105110-20 (2007); Sharp vorticity gradients in two-dimensional turbulence and the energy spectrum, Theor. Comput. Fluid Dyn., 24(1-4), 253-258 (2010).