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Title: Self-similar Decay of Generalized Two-dimensional Turbulence

Abstract:

We study decaying two-dimensional turbulence governed by the so-c turbulence equations (Pierrehumbert et al 1994). The equations is a f two-dimensional imcompressible fluid models indexed by a parameter family of equations includes the Navier-Stokes equation (α= 2), the s quasi-geostrophic equation (α= 1), and the Charney-Hasegawa-Mima equation in the asymptotic model(AM) regime (α= - 2). In the invici the equations have two quadratic invariants, the energy and the enst self-similarity theory is proposed for α turbulence. The result of Iwaya Shepherd(2004) is generalized to α turbulence. We drive a necessary condition for the existence of a self-similar energy spectrum. Our the predicts the critical Reynolds number decay law for the decaying NS turbulence with usual viscosity, which is found numerically by Chasno (1997). The theory also predicts the decay law for the CHM tubulence AM regime with hyperviscosity, which is found numerically by Iwayam (2002). We perform direct numerical simulations for the surface quas geostrophic equation (α=1) with usual viscosity to study whether the spectrum decays self-similarly. The numerical simulation results yield power-law decay of the energy and the enstrophy, and the self-simila of the energy spectrum. Our theory and the numerical simulation resu in good agreement.

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