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The turbulence dissipation constant is proportional to the number of large-scale stagnation points and is therefore not universal

JOHN CHRISTOS VASSILICOS, Imperial College London, London, UK, SUSUMU GOTO, Kyoto University, Kyoto, Japan — Bos et al (PoF 19, 045101, 2007) showed how the turbulence dissipation constant C_ϵ can differ between stationary and decaying homogeneous isotropic turbulence (HIT) and Mazellier & Vassilicos (PoF 20, 015101, 2008) showed how this constant is in fact proportional to the third power of the number of large-scale zero-crossings of a 1D velocity component signal sampled from a 3D HIT. Their result implies and quantifies the non-universality of C_ϵ and was obtained by application of the Rice theorem and the 2/3 scaling-range scaling of the number density of zero crossings (Davila & Vassilicos PRL 91, 144501, 2003). We generalise the Rice theorem to stagnation points and use it in conjunction with the exponent 2 scaling-range scaling of the number density of stagnation points (Davila & Vassilicos 2003) to show that C_ϵ is proportional to the number of large-scale stagnation points in HIT. We run DNS of HIT with different low wavenumber energy spectra and show that different values of C_ϵ result from these different simulations, and that these different values are well accounted for by the differences in stagnation point structure of the different HIT flows. Our formula linking C_ϵ to this stagnation point structure allows to collapse all data into a single Re_λ-dependence curve and explains, quantitatively, the non-universality of C_ϵ.

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