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Wavelet-spectral analysis of droplet-laden isotropic turbulence
ANDREAS FREUND, ANTONINO FERRANTE, University of Washington — The energy spectrum for homogeneous isotropic turbulence is computed using the Fourier transform of the velocity field. In the case of multiphase turbulent flows, the velocity field is nonsmooth at the interface between the carrier fluid and the dispersed phase, so the Fourier energy spectra exhibit spurious oscillations at high wavenumbers. An alternative definition of the spectrum uses the wavelet transform, which can handle discontinuities locally while additionally preserving spatial information about the field. We propose using the wavelet energy spectrum to study multiphase turbulent flows and a new decomposition of the wavelet energy spectrum into three contributions corresponding to the carrier phase, droplets, and interaction between the two. Lastly, we apply the new wavelet-decomposition tools in analyzing the DNS data of droplet-laden decaying isotropic turbulence. Our results show that, in comparison to the spectrum of the single-phase case, the droplets (i) do not affect the carrier-phase energy spectrum at high wavenumbers, (ii) increase the total energy spectrum at high wavenumbers by increasing the interaction energy spectrum at these wavenumbers, and (iii) decrease the total energy at low wavenumbers by increasing the dissipation rate at these wavenumbers.

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