Energy spectra in polymer-doped turbulent soap films

RORY CERBUS, WALTER GOLDBURG, University of Pittsburgh, PINAKI CHAKRABORTY, OIST, NATHAN FLYNN, University of Pittsburgh, CHIENCHIA LIU, OIST — We investigate the energy spectra of turbulent soap films doped with a dilute amount of a very large molecular weight polymer (> 1M). We perform experiments in a soap-film channel that in the absence of polymers manifests decaying turbulence and a direct enstrophy cascade: the energy spectrum $E(k) \propto k^{-3}$. For polymer-doped flow, where the polymer is added gently to the soapy solution, we observe that the energy spectrum switches to $E(k) \propto k^{-5/3}$, which is consistent with the inverse energy cascade of forced 2D turbulence. This switching of the spectral exponent from 3 to 5/3 occurs for polymer concentrations as low as 2 wppm. For lower concentrations, the spectral exponent is unaffected. We also find that our results are sensitive to the method of polymer doping. If we stir our polymer-doped solution repeatedly, the effect of the polymer diminishes: the exponent of the energy spectrum switches back from 5/3 to 3.

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