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Particle-laden viscoelastic turbulence in channel flow[1]

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Individually, viscoelasticity and particles can appreciably modify channel-flow turbulence: The addition of polymers can quench the turbulent shear stress and enlarge the coherent streamwise velocity-perturbation structures; it can also cause the turbulence to cycle between an active and a hibernating state. In contrast, dilute particle concentrations can enhance the turbulent shear stress and weaken the streamwise velocity disturbances. When both viscoelasticity and the particle phase are present, the dynamics become much more intriguing as we demonstrate using direct numerical simulations of particle-laden viscoelastic turbulence in a channel. A dilute concentration (5%) of neutrally buoyant particles can aggressively amplify the cycles of hibernating and active viscoelastic turbulence. These cycles, in turn, modulate the particle migration between the channel centre and the near-wall region. Within the global dynamics is interesting micro-scale phenomenology: The particle-pair distribution function indicates that viscoelasticity leads to an exclusion corridor upstream and downstream of the particle, in the streamwise direction. An explanation is provided by contrasting the conditionally averaged fields around the particles in the Newtonian and viscoelastic conditions.

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