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Drag and turbulence modulation by particles and viscoelasticity in channel flow[1] AMIR ESTEGHAMATIAN, TAMER ZAKI, Johns Hopkins University — Direct numerical simulations are performed to examine the effect of neutrally-buoyant particles on turbulence and drag in viscoelastic channel flow. Comparison is drawn between the single-phase conditions and semi-dilute suspensions of particles (20% solid volume fraction), at various Weissenberg numbers. Viscoelastic effects are included using the FENE-P model, and an immersed-boundary method that is tailored for simulations of non-Newtonian particle-laden flows is used to impose the rigid-body motion at the surface of the particles. The results highlight a remarkable contrast in drag modulation between the single-phase and particle-laden conditions. Unlike the single-phase cases, the particle-laden flows undergo a drag enhancement with increasing viscoelasticity above a certain Weissenberg number. This effect is due to a drastic increase in polymer stresses near the surfaces of particles. Nonetheless, Reynolds stresses are effectively diminished in the particle-laden viscoelastic cases. In fact, the onset of viscoelastic drag enhancement in the particle-laden flows occurs when the Reynolds stresses are completely eradicated and the higher viscoelasticity results in increased polymer stresses.

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Amir Esteghamatian
Johns Hopkins University

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