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Lattice Boltzmann studies of drag reduction in turbulent channel flow with polymers. ALEXANDER KARPIKOV, Yale University, S.A. ORSZAG, K.R. SREENIVASAN — Massive drag reduction in turbulent flow by dilute addition of polymers has long been a challenging problem in fluid dynamics. In order to study this problem here we use the Lattice Boltzmann method (LBM) to simulate turbulent channel flow. A polymer model, which is macroscopically equivalent to the FENE-P model, is included in LBM to represent polymers. Drag reduction with polymers was observed in the simulations. Although such drag reduction has been demonstrated in laboratory experiments, the mechanisms are not yet clear. In order to understand these results we investigated the role of dilute polymers on Kelvin-Helmholtz instability in the much simpler turbulent mixing layer. Our simulations of the mixing layer show that polymers produce a stabilizing effect and suppress momentum transport due to fluctuating velocity components. The simulations of these two systems together provide a clearer picture of the interaction between polymers and coherent structures in the near-wall region of the turbulent flow and shed light on the mechanism of drag reduction. The addition of polymers primarily modifies turbulent bursts in channel flow, and this phenomenon has several features in common with the effect of polymers on Kelvin-Helmholtz instability in the mixing layer.

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