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Turbulent drag reduction by additives

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Turbulent drag reduction by additives Daniel Bonn ENS/LPS Paris, France and WZI Amsterdam, The Netherlands A spectacular reduction of energy losses in turbulent flows can be achieved by the addition of small amounts of certain polymers or surfactants. I will discuss a few of our recent experiments that shed some light on the different possible mechanisms of drag reduction. Polymer drag reduction is believed to be due to the large elongational viscosity of the polymer solution; this stabilizes the turbulent boundary layer, leading to less turbulent energy generation, and hence less dissipation. For flexible polymers, indeed a correlation between drag reduction and elongational viscosity can be found. We show however that solutions of rigid polymers that exhibit no measurable elastic effects, drag reduction is as efficient as for flexible polymer solutions with an elevated elongational viscosity. This drag reduction can be attributed to the existence of a spatial viscosity gradient in the boundary layer. For surfactants, we show that drag reduction is due to an effective wall slip. Due to the wall slip, the bulk of the turbulent system does not experience a large wall friction. Since it is the wall friction that generates the turbulence, this naturally leads to a smaller dissipation.