Some considerations on the contact line problem with dilute polymer solution drops impacting on a hydrophobic substrate

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The moving contact line of a dilute polymer solution that advances over, or recedes from a solid substrate, is a fundamental problem of fluid dynamics with important practical applications, including coating and thin film deposition processes, sprays, bio- and micro-fluidics. Experiments show that while the advancing motion proceeds as with Newtonian liquids, recession is severely inhibited (see Fig. 1). This phenomenon was initially understood as an effect of elongational viscosity\(^1,2\), which was believed to cause large energy dissipation in the fluid. Later on, a hydrodynamic mechanism was proposed to suggest that the slowing down of the contact line is due to non-Newtonian normal stresses generated near the moving droplet edge\(^3\).

However, recent experiments\(^4\) ruled out the role of elongational viscosity, showing that the fluid velocity measured inside the droplet during retraction is the same in water drops and polymer solution drops. Moreover, direct visualisation of fluorescently stained \(\lambda\)-DNA molecules showed that polymer molecules are stretched perpendicularly to the contact line as the drop edge sweeps the substrate, which suggests an effective friction arises locally at the drop edge, causing the contact line to slow down.

Here, we bring further evidence in support of this mechanism, highlighting some flaws in the previous approaches.

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![Figure 1: Impact and retraction of a dilute polymer solution drop on a solid substrate.](image-url)