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Effect of surface elasticity on the rheology of nanometric and micrometric liquids

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The rheological properties of liquids confined to nanometer scales are important in many situations, yet are still a widely debated topic. The change in bulk viscosity and apparition of visco-elasticity under confinement is a particularly controversial question. In this talk, we use a new approach for this problem by addressing the effect of the long-range elastic deformations of the confining surfaces on the liquid flow. This effect could help reconciling some discrepancies within the literature concerning the intrinsic mechanical behavior of nanometric liquids. In the case of a squeeze-flow geometry, we show that below a critical distance Dc, the liquid is clamped by its viscosity and its intrinsic properties cannot be disentangled from the global system response. The theoretical approach [1] is confirmed by nanorheology experiments [2, 3] on various simple liquids, using both very soft (PDMS) and very rigid (Pyrex) confining surfaces. In every case we demonstrate that the elastic deflections of the confining surfaces, even if they are of very small amplitude, can dominate the overall mechanical response of nanometric liquids confined between solid walls.

[1] S. Leroy & E. Charlaix, J. Fluid. Mech. 674, pp. 389-407 (2011)
[2] S. Leroy *et al.*, Phys. Rev. Lett. 108, 264501 (2012)
[3] R. Villey *et al.,* Phys. Rev. Lett. 111, 215701 (2013).