Instabilities in the spatiotemporal dynamics of a shear-thickening cornstarch suspension

PRX **8**, 031006 (2018)

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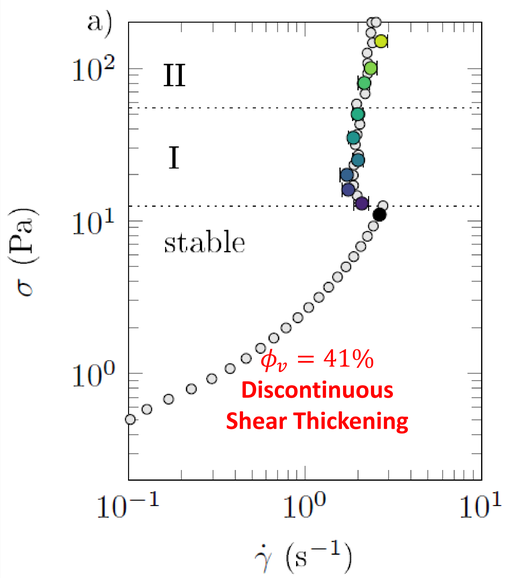
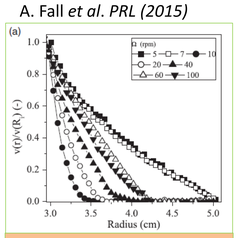
State of the art



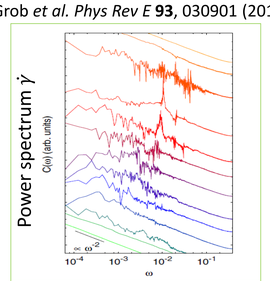
A. Fall *et al. PRL (2015)*



Localization, solidification?

⚠ *Very large couette $\Delta\sigma/\sigma$=1.8*

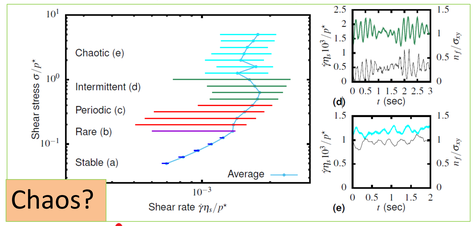
Grob *et al. Phys Rev E* **93**, 030901 (2016)



Statistical properties?

⚠ *2D simulation*

Hermes *et al., J. Rheol.* **60**, 905 (2016)



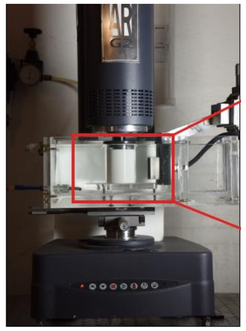
Chaos?

⚠ *Parallel plate surf/vol=1cm-1*

Setup and experiments

Gallot *et al., Rev. Sci. Instr.* **84**, 045107 (2013)

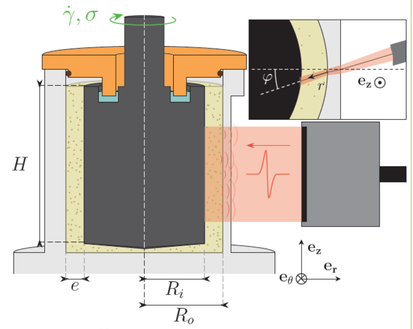
Small gap



e=2mm=150a

surf/vol=0.03cm-1, $\Delta\sigma/\sigma$=0.18

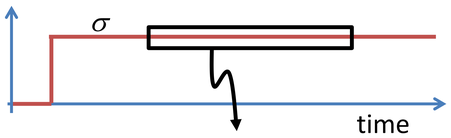
Solvent trap



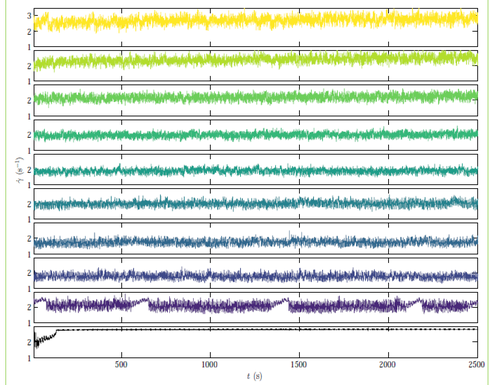
Couette geometry

solvent trap to avoid evaporation

Rheology coupled to Echography

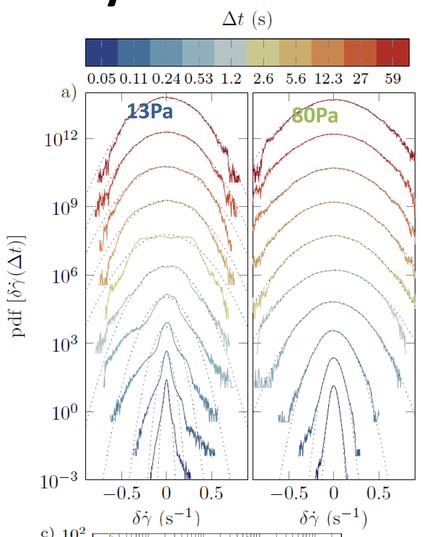


Shear rate response over ~3000s

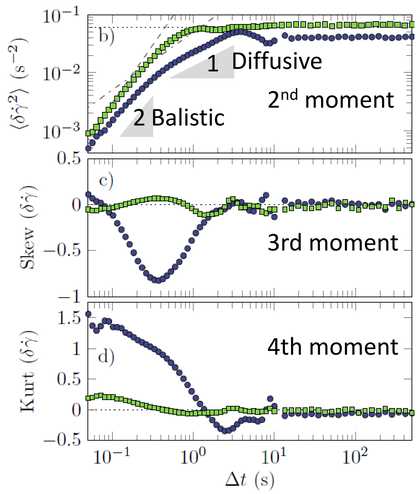


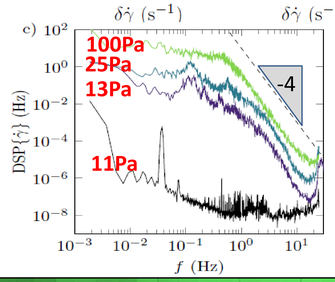
Steady stress experiment

Analysis of the shear rate increments



$$\delta\dot\gamma(\Delta t) = \dot\gamma(t) - \dot\gamma(t+\Delta t)$$

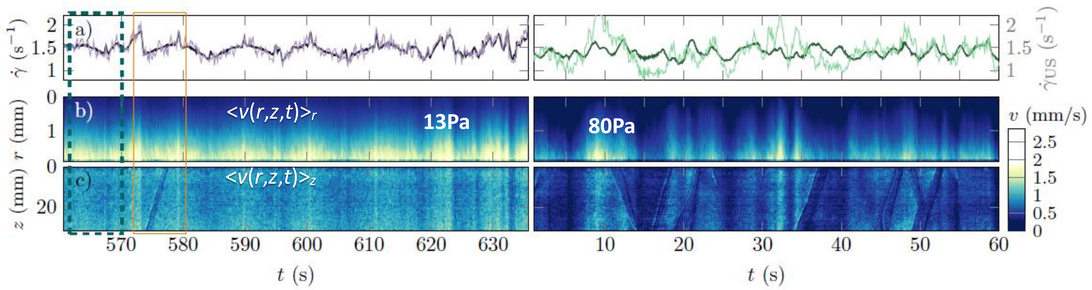


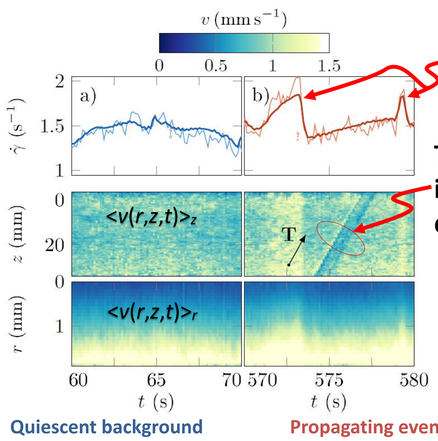


$\Delta t \lesssim 1$ s
Mixed dynamics

$\Delta t \gtrsim 1$ s Gaussian, uncorrelated

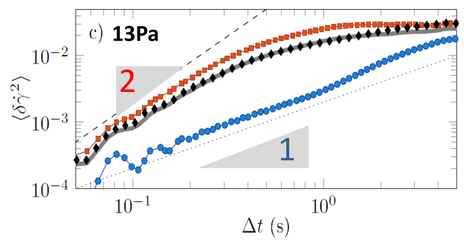
Insight from echography





Acceleration decelaration

Traveling band in the vorticity direction



$$\langle\delta\dot\gamma^2\rangle = \alpha\,\langle\delta\dot\gamma^2\rangle_P + \beta\,\langle\delta\dot\gamma^2\rangle_Q$$

The statistical properties of the dynamics result from **Propagating events** and **Quiescent background**

The decomposition fit all the stresse series: No Chaos

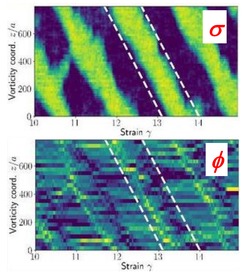
Conclusion

DST in cornstarch under steady shear stress

⇒ nature of the instability = travelling azimuthal bands

v= 10 mm/s

- Unsteady yet homogeneously sheared flow
- Signal analysis ⇒ ballistic vs diffusive dynamics
- Ultrasound ⇒ travelling slip bands (not stick-slip)
- Compatible with recent model & simulations



R. N. Chacko, R. Mari, M. E. Cates, and S. M. Fielding *PRL* ***121***, *108003 (2018)*