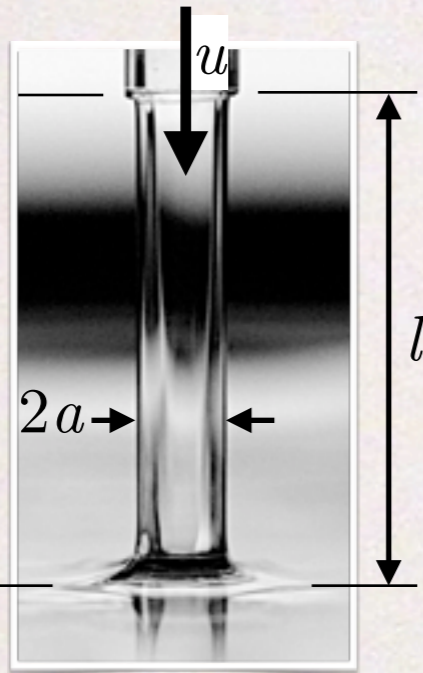


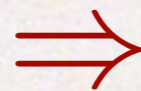
VISCOELASTIC SYMMETRY BREAKUP OF JETS, SHEETS & HYDRAULIC JUMPS

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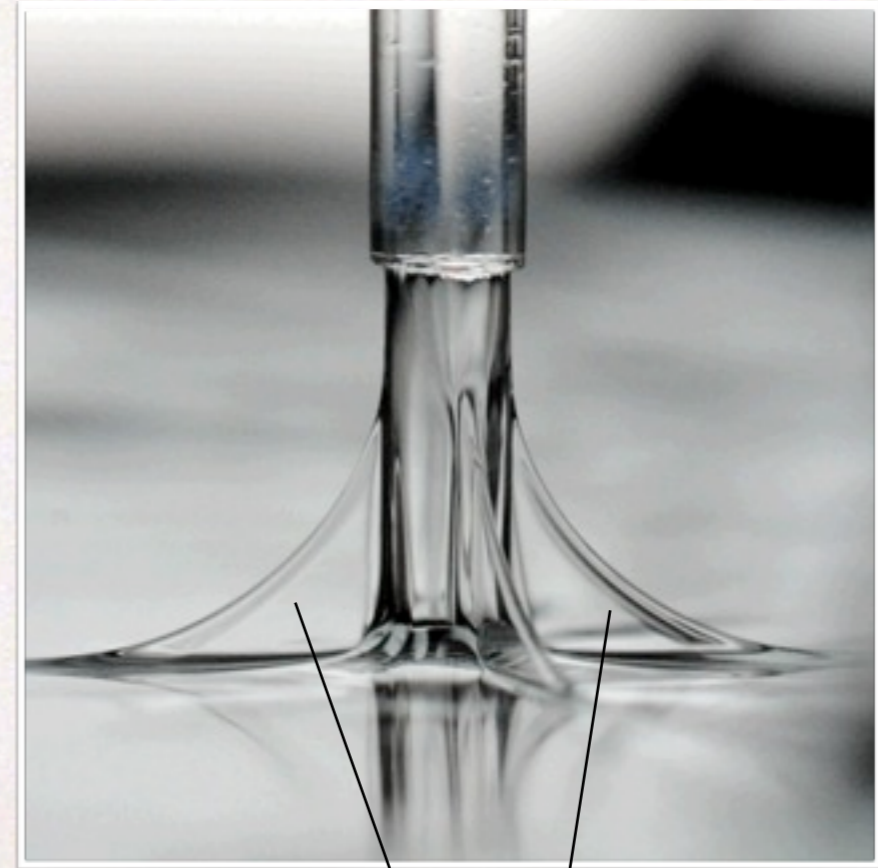
High velocity
viscoelastic jet
(PEO in H₂O)



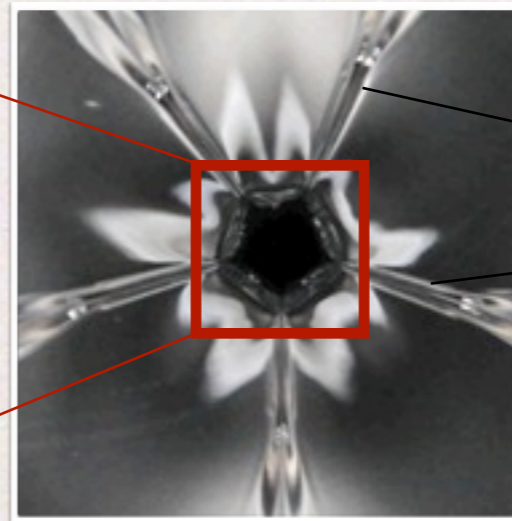
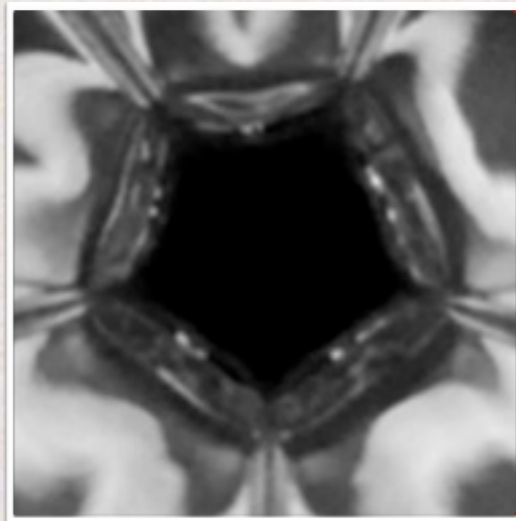
Increase u
or
decrease l



Webbed jet (symmetry breakup)



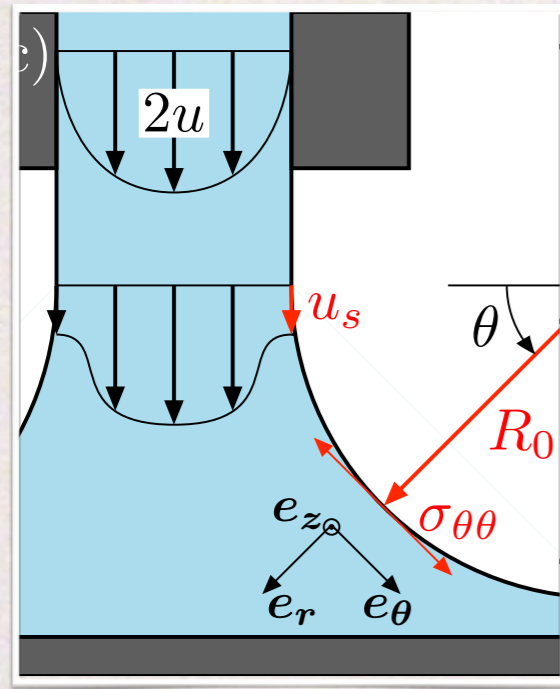
Bottom view



Wings
(radial & steady
liquid films)

MECHANISM

Destabilizing pressure gradient at the interface



Shear

$$\Rightarrow \Delta\sigma = \sigma_{11} - \sigma_{22}$$

(visco-elastic effect)

Surface velocity relaxation

$$\Rightarrow l\text{-dependance}$$

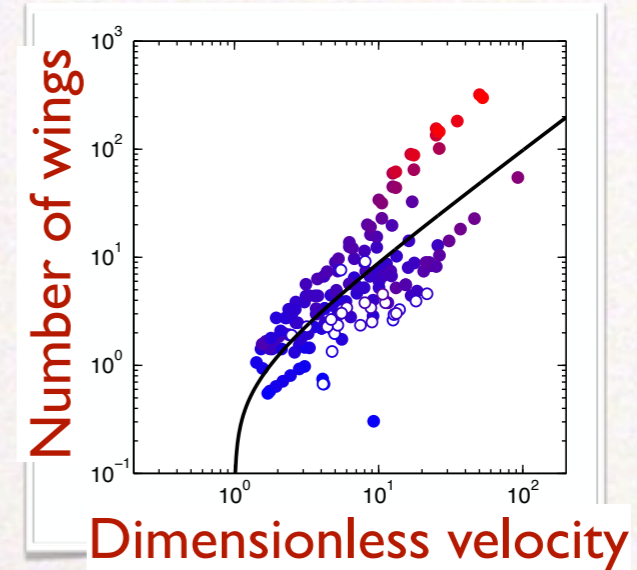
Deflection

$$\Rightarrow \text{curved interface } R_0$$

$$R = R_0 e^{ikz + \omega R_0 \theta / u_s}$$

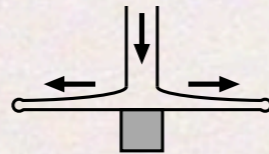
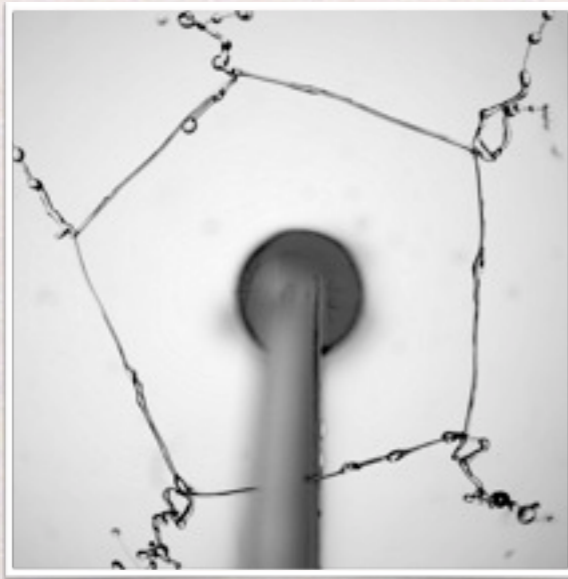
$$\rho\omega^2 = \frac{\Delta\sigma}{R_0} - \rho u_s^2 k - \gamma k^3$$

- Normal stress destabilizes
- Inertia & surface tension stabilize



LARGE-SCALE CONSEQUENCES

Receding edge



Hydraulic jump

