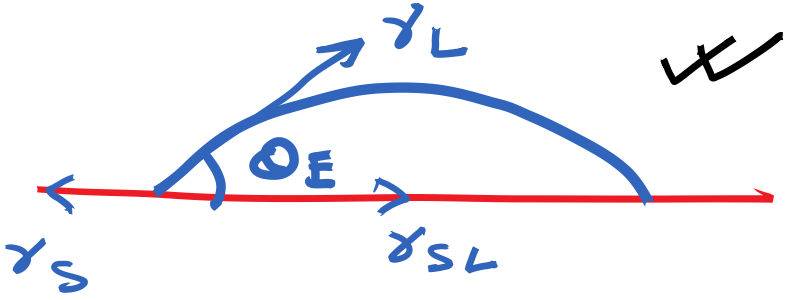
Liquid drop on a Solid Surface

31 st January 2022

Lecture - 09



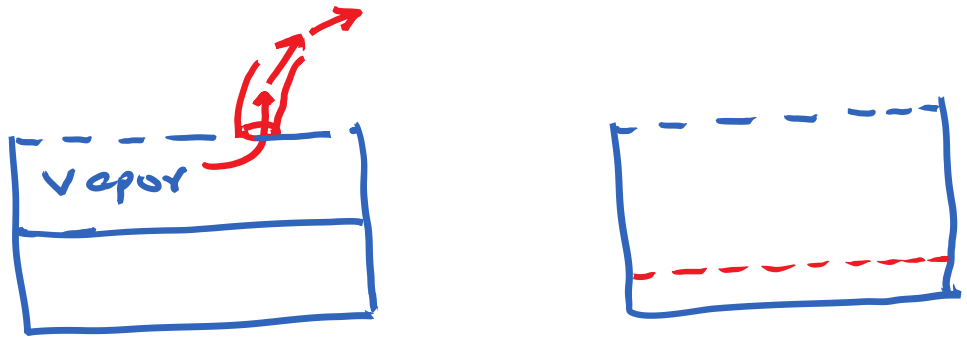
$$\gamma_S = \gamma_{SL} + \gamma_L \cos\theta_E$$

What happens if this drop is Left for a long time ?

→ Liquid will Evaporate.

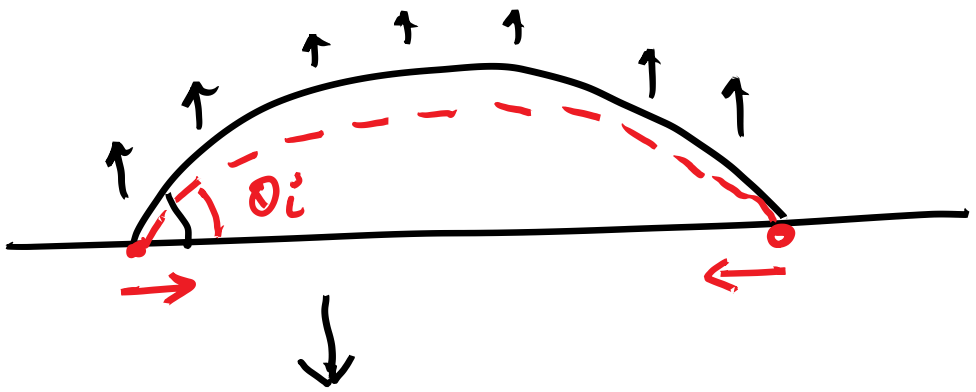
Pinning ⇒ CAH

Critical Sliding Cless → α_c



Breathing Loss.

What will be the Consequence of Evaporation on the drop (Shape/Geometry).



In case the drop is pinned (Contact line does not retract)

⇒ θ_i is going to be lower than θ_E.

Force is no longer balanced. There is a net inward force.

→ Pinning is Possible

Surfaces can be classified in three broad ways based on Extent of Pinning.

→ With NO PINNING.

→ With Total/Complete/infinite pinning

→ Surface with Finite Pinning.

(Most Surfaces are like this)

Some $\alpha = \alpha_c$, → drop starts to move.

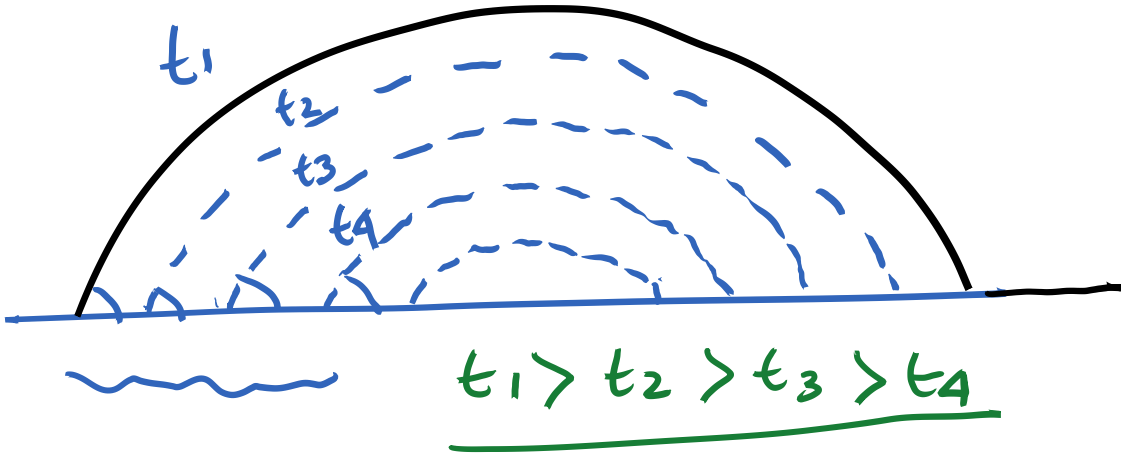
(1) Loss of mass

(2) Volume reduces

(3) — Net inword force.

CCA mode: "Const Contact Angle" Mode of Evaporation.

(1) Surface with NO PINNING → Frictional resistence to movement of the Contact line is Negligible.



$t_1 > t_2 > t_3 > t_4$

So drop retracts.

At all instence $\theta_i \simeq \theta_E$

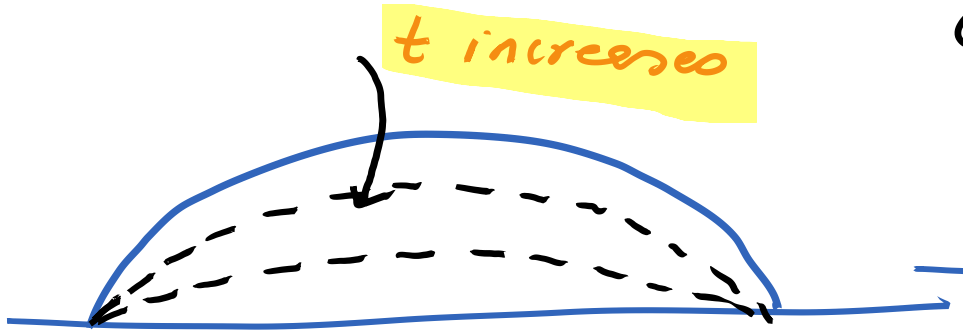
Drop becomes smaller with time → θ_E remains constant

→ Drop remains Geometrically Smiler at all times.

$t \rightarrow$ large value or ∞

"Gone With the Wind"

(2) Surface has Complete / Total / infinite Pinning.



Contact Line is going to be Completely pinned.

→ The drop flattens with time.

→ Late stage → It will almost get converted to a film.

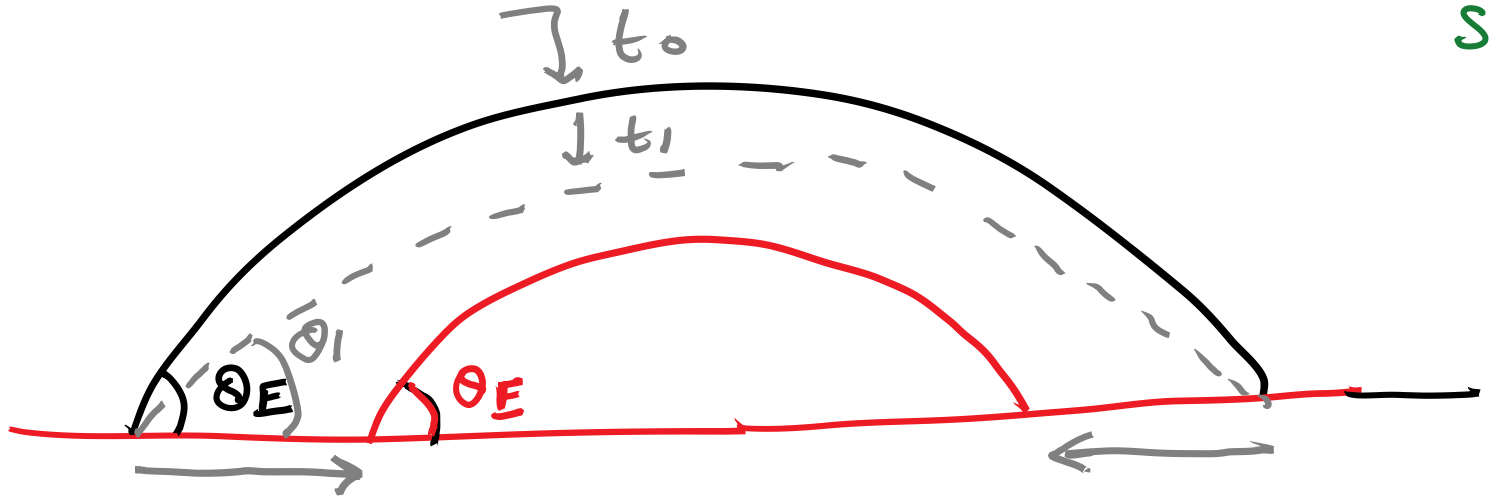
↳ There is always a net inward pull (Force Not Balanced)

Strength of adhesive force between liq molecules & Solid is so high → Imbalance at the contact line fails to move the contact line.

CCR Mode: Constant Contact Radius mode of Evp

(3) Evaporation of a liquid Drop on a Surface With FINITE pinning.

→ Imbalance of the contact line is going to overcome the strength of adhesion (or strength of the pinning force) after some finite value of the imbalance.



From t_0 to t_1 → Contact line does not move

θ drops from θ_E to θ_1

There is an imbalance.

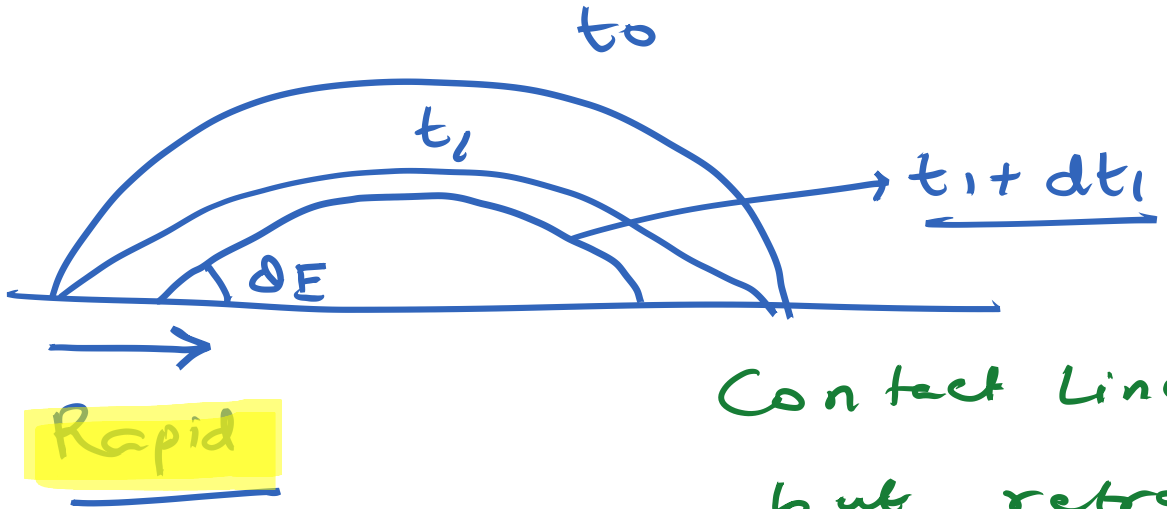
$t = t_1$ → The imbalance at the contact line overcomes the pinning → Contact line will rapidly retract

→ Till θ_i again becomes θ_E.

Initially Pinned → followed by rapid retraction.

→ till $\theta_i \approx \theta_E$ again → Again Pinning → Followed by Rapid retraction.

Mixed Mode of Evaporation



Sequential Pinning and depinning →

Contact Line is not retracting uniformly but retracts in bursts.

Motion of the Contact Line → Stick Slip Motion

↓ When it is pinned

↳ Rapid retraction