3. Wetting

Puddles. What sets their size?
Knowing nothing of surface chemistry, one anticipates that Laplace pressure balances hydrostatic pressure if $\sigma/H \geq \rho g H \Rightarrow H < \ell_c = \sqrt{\sigma/\rho g}$ = capillary length.

`Note`:

1. Drops with $R < \ell_c$ remain heavily spherical
2. Large drops spread to depth $H \sim \ell_c$ so that Laplace + hydrostatic pressures balance at the drop's edge. A volume V will thus spread to a radius R s.t. $\pi R^2 \ell_c = V$, from which $R = (V/\pi \ell_c)^{1/2}$.
3. This is the case for H_2O on most surfaces, where a contact line exists.

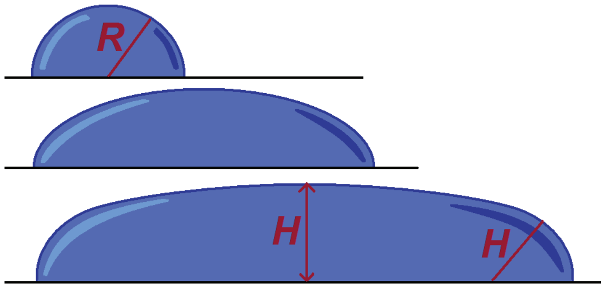

Figure 3.1: Spreading of drops of increasing size.

`Note`: In general, surface chemistry can dominate and one need not have a contact line.

More generally, **wetting** occurs at fluid-solid contact. Two possibilities exist: *partial wetting* or *total wetting*, depending on the surface energies of the 3 interfaces $(\gamma_{LV}, \gamma_{SV}, \gamma_{SL})$.

Now, just as $\sigma = \gamma_{LV}$ is a surface energy per area or tensile force per length at a liquid-vapour surface, γ_{SL} and γ_{SV} are analogous quantities at solid-liquid and solid-vapour interfaces.
The degree of wetting determined by *spreading parameters*:

$$S = [E_{substrate}]_{dry} - [E_{substrate}]_{wet} = \gamma_{SV} - (\gamma_{SL} + \gamma_{LV}) \tag{3.1}$$

where only γ_{LV} can be easily measured.
Total Wetting: $S > 0$, $\theta_e = 0$ liquid spreads completely in order to minimize its surface energy. e.g. silicon on glass, water on clean glass.

`Note`: Silicon oil is more likely to spread than H_2O since $\sigma_w \sim 70\ dyn/cm\ >\ \sigma_{s.o.} \sim 20\ dyn/cm$. Final result: a film of nanoscopic thickness resulting from competition between molecular and capillary forces.

Partial wetting: $S < 0$, $\theta_e > 0$. In absence of g, forms a spherical cap meeting solid at a contact angle θ_e. A liquid is "wetting" on a particular solid when $\theta_e < \pi/2$, non-wetting or weakly wetting when $\theta_e > \pi/2$. For H_2O, a surface is hydrophilic if $\theta_e < \pi/2$, hydrophobic if $\theta_e > \pi/2$ and superhydrophobic if $\theta_e > 5\pi/6$.

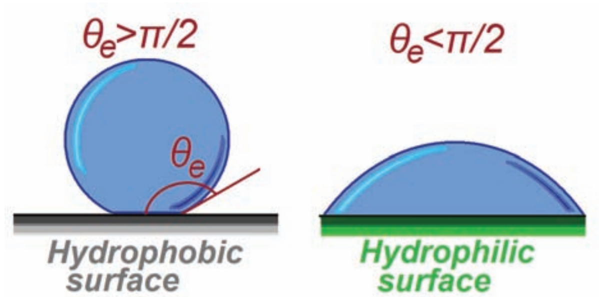

Figure 3.2: The same water drop on hydrophobic and hydrophilic surfaces.

`Note`: if $g = 0$, drops always take the form of a spherical cap $\Rightarrow$ flattening indicates the effects of gravity.

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Fall 2010