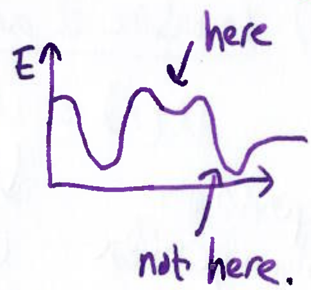
COLLOIDS : MEGA TUTORIAL !

JDP

① **Colloidal dispersion** :- kinetically stable
- thermodynamically unstable



i.e. colloidal dispersions can irreversibly combine ("coagulate"). e.g. curdled milk, split hollandaise

② **Interactions** : consider attractive + repulsive interactions between particles. (energy $U(r)$, where r is separation).

Ⓐ **Attractions** : van der Waal's [1] / dispersion forces.

never sure about this → [1]

short Range (r^{-6}) ⟶ Long Range (r^{-1})

Molecule + Molecule | Molecule + surface | surface + surface | spherical colloids

$U(r) \sim (-) \frac{1}{r^6}$ — $-$ve : attractive

$U(r) \sim -\frac{1}{r^3}$

$U(r) \sim -\frac{1}{r^2}$

$U(r) \sim -\frac{a}{r}$

Key idea : short range v.d.W become longer range when summed across many particles.

Ⓑ **Repulsions** : i) Hard sphere repulsion ($U(r) \sim (+) \frac{1}{r^{12}}$) ← V.V.V. short range

+ve : repulsive

ii) Double Layer repulsion ($U(r) \sim +\exp(-r)$)

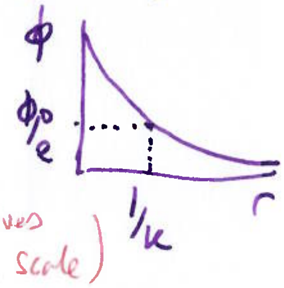
↑ short / intermed. range.

Why $\exp(-r)$? Consider electric potential, $\phi(r)$:

$$\frac{d^2\phi}{dr^2} = k^2\phi \quad \text{("Poisson's Equation")}$$

$$\rightarrow \phi(r) = \phi_0 \exp(-kr)$$

$\frac{1}{k}$ = Debye screening length. (i.e. gives length scale)



③ Combine it all together...

$$U(r) = U(\text{attraction}) + U(\text{repulsion})$$

- $U(\text{attraction})$ ↳ dispersion, $U \sim -1/r,\ -1/r^2$ — depends on system geometry
- hard sphere ($U \sim 1/r^{12}$)
- ↳ Double Layer ($U \sim \exp(-r)$)

e.g. 2 surfaces: $U(r) \propto \frac{1}{r^{12}} + \exp(-r) - \frac{1}{r^2}$

→ This is DLVO theory. Easier to sketch...

salt, pH, etc... → e.g. need to add lemon to milk to make paneer.

Key: Tuning properties of colloidal dispersion affects barrier heights + well depths, so affects colloidal stability