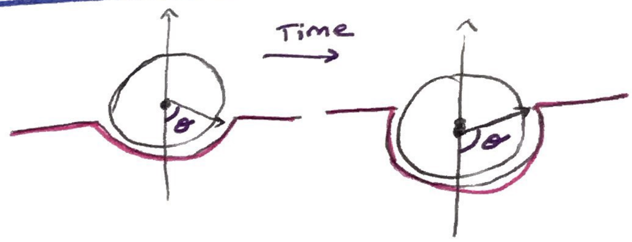
"Time to wrap"

$$\boxed{E_{tot} = -\int_{A_{ad}} \overbrace{\tilde{W}}^{\text{Adhesion energy per area}}\, dA + \int_{A_{mem}} 2\kappa \overbrace{H}^{\text{Mean curvature}}{}^2\, dA + \overbrace{\tilde{\sigma}}^{\text{tension}} \Delta A}$$

Uptake force $= -\frac{dE_{tot}}{ds}$

$= -\frac{1}{R}\frac{dE_{tot}}{d\theta}$



Friction: "membrane microviscosity" $\eta = 1\,\mathrm{Pa\,s}$

$F_{fric} = \eta\,(2\pi R \sin\theta)\, R\dot{\theta}$ (η x change in membrane-covered colloid surface)

$$\eta\, 2\pi R^2 \sin\theta\, \dot{\theta} = -\frac{1}{R}\frac{dE_{tot}}{d\theta}$$

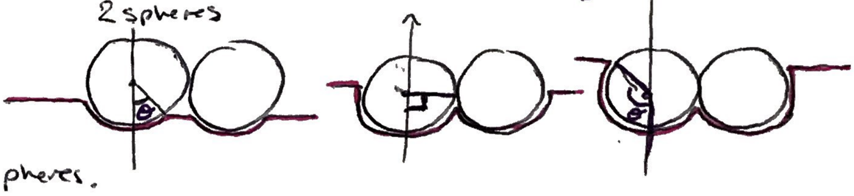
... Evaluate & Integrate ...

$$\boxed{T^{0}_{det} = \frac{2\tan^{-1}\left[\sqrt{1-\frac{2\nu_\sigma}{\nu_{up}}}\,\tan\frac{\pi}{2}\right]}{\nu_{up}\sqrt{1-\frac{2\nu_\sigma}{\nu_{up}}}}}$$

$$\boxed{\nu_{up} = \frac{W}{R\eta} - \frac{2\kappa}{R^3\eta}} \qquad \boxed{\nu_\sigma = \frac{\sigma}{R\eta}}$$

$$\left(f(\underbrace{W}_{\text{Change}}, \underbrace{R}_{\text{change}}, \underbrace{\eta}_{=1}, \underbrace{\kappa}_{=25 k_BT}, \underbrace{\sigma}_{\text{change}})\right)$$

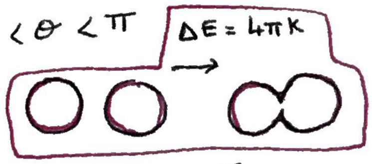
What about Dumbbell Instead?



- Before $\theta = \frac{\pi}{2}$ $\left(0 < \theta < \frac{\pi}{2}\right)$,

Dumbbell case just the same as 2 spheres.

$$E_{tot} = \underbrace{-2\,W(\theta)}_{\text{Adhesion term}} + \underbrace{2\sigma\Delta A(\theta)}_{\text{Tension term}} + \underbrace{2\,\kappa(\theta)}_{\text{bending term}} + \begin{cases} \cancel{0 \quad 0<\theta<\frac{\pi}{2}} \\ 4\pi\kappa f(\theta) \quad \frac{\pi}{2} < \theta < \pi \end{cases}$$



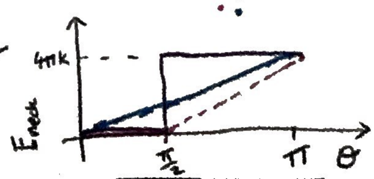
$F_{fric} = 2 \times F_{fric}^{sphere}$

$$\dot{\theta} = \underbrace{\frac{W}{R\eta} - \frac{2\kappa}{R^3\eta} + \frac{\sigma}{R\eta}(1-\cos\theta)}_{\text{Equation for the sphere}} - \underbrace{\frac{1}{2R}\frac{d}{d\theta}\begin{cases} \cancel{0 \quad 0<\theta<\frac{\pi}{2}} \\ f(\theta)\times 4\pi\kappa \quad \frac{\pi}{2}<\theta<\pi \end{cases}}_{\text{Extra bit due to neck}}$$

not actually discontinuous. ??

→ Assume neck energy accumulates linearly with θ

??↑



$$\dot{\theta} = \nu_{up} - \frac{2\pi k}{R} + \frac{\nu_\sigma}{\text{[illegible]}}(1 - \cos\theta)$$

$$T_{det}^{\infty} = \frac{2\tan^{-1}\left[\sqrt{1 - \frac{2\nu_\sigma}{\nu_{up} - \frac{2\pi k}{R}}}\ \tan\frac{\pi}{2}\right]}{\left(\nu_{up} - \frac{2\pi k}{R}\right)\sqrt{1 - \frac{2\nu_\sigma}{\nu_{up} - \frac{2\pi k}{R}}}}$$