## Entropy spring

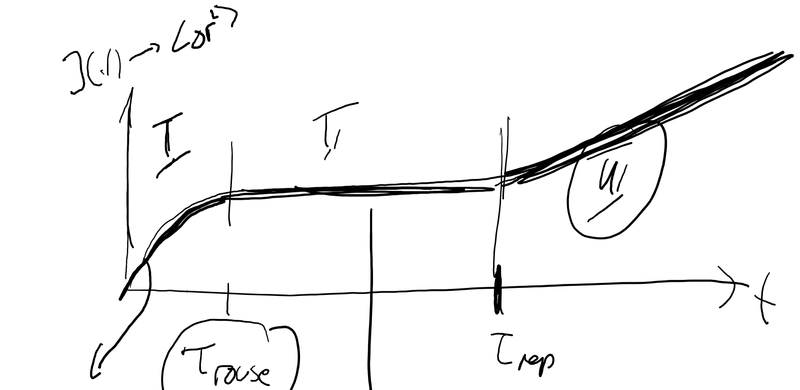
$$\text{force} = -\frac{\partial F_p}{\partial y} = \frac{\partial T S_p}{\partial y} = T\frac{\partial S_p}{\partial y} = k_B T\,\frac{\partial \ln Z(y)}{\partial y}$$

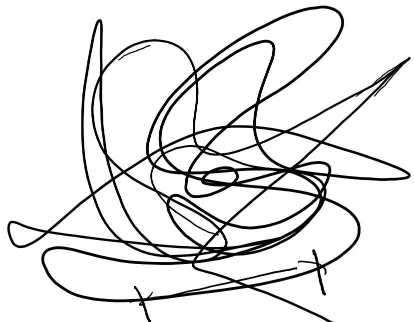
$$S_p = k_B \ln(Z(y))$$

$$Z(y) \sim e^{-\frac{y^2}{2R_g^2}} \longrightarrow \ln Z(y) = -\frac{y^2}{2R_g^2} + \text{const}$$

$$\text{force} = -k_B T\,\frac{2y}{2R_g^2} = -\boxed{\frac{k_B T}{R_g^2}}\cdot y$$

"spring constant" $\sim k_B T$



diffusion over travelling thru the molecule

→ elastic plateau → entropy spring

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## Rouse-equation

$$f_{fr} = f\cdot\frac{\partial \vec r_n}{\partial t} \qquad f_n = c\,\frac{\partial^2 \vec r_n}{\partial n^2}$$

$$\frac{\partial \vec{r}_n}{\partial t} = \boxed{\frac{c}{f}} \frac{\partial^2 \vec{r}_n}{\partial n^2} \rightarrow \boxed{\tau_p = \frac{f}{c} \cdot \frac{1}{L^2}}$$

↳ "Diffusivity"

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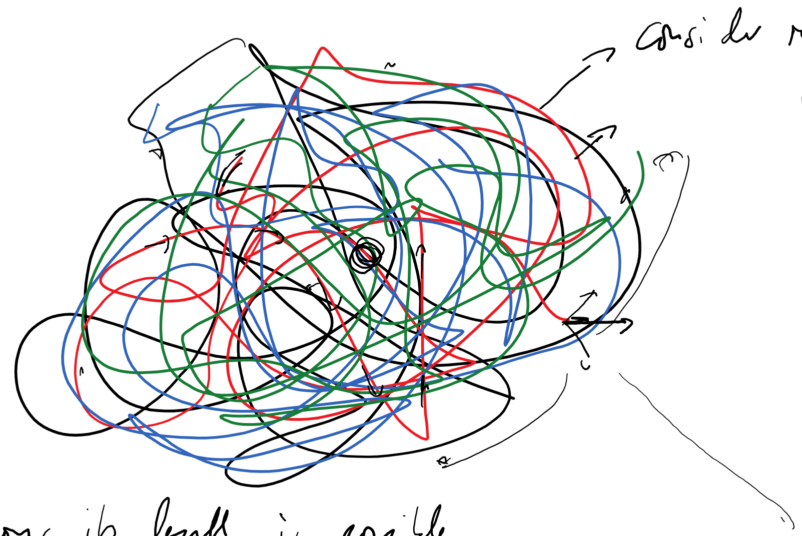
$\tau_{Rep}$



consider red molecule
↳ limited in position to its radius of gyration

movement along its length is possible

time scale involved to move out of current "cage"

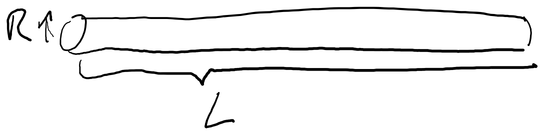
$\tau_{1D,\,diff}$ for length $L$

$$\boxed{\tau_{1D} = \frac{L^2}{2 D_{1D}} \sim \frac{\eta L^3}{2kT}}$$

Einstein: $D_{1D} = \frac{kT}{f_{1D}}$

$f_{1D}$: friction coefficient of a long cylinder

$f_{1D} \sim \eta \cdot$ length scale $\sim \eta L$

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Diffusivity for the molecule in 3D: $D_{3D} = \frac{R_g^2}{\tau_{Rep}}$

$$\boxed{D_{3D} \sim \frac{L \cdot l_p k_B T}{\eta L^3} \sim \frac{k_B T \cdot l_p}{\eta L^2}}$$

($L_{Rep}$)

$\langle \delta r^2 \rangle = D_{3D} \cdot t$ $\Longrightarrow$ effective viscosity much larger than solvent viscosity