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Lec-2
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1

$$X_{rms} = \sqrt{\langle x^2 \rangle} \propto \sqrt{t}$$

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$$\propto t^{\frac{1}{2}}$$

$$\frac{\partial}{\partial t}\underbrace{\boxed{\int_{-\infty}^{\infty} x\,\tilde{C}(x)\,dx}}_{\langle C\rangle} = D\int_{-\infty}^{\infty} x\,\frac{\partial^2 \tilde{C}}{\partial x^2}\,dx$$

$$\frac{\partial}{\partial t}\langle C\rangle = D\int_{-\infty}^{\infty} \underbrace{x}_{u}\overbrace{\left(\frac{\partial^2 \tilde{C}}{\partial x^2}\right)}^{\left(\frac{\partial v}{\partial x}\right)} dx$$

$$\int_{-\infty}^{\infty} u \frac{\partial v}{\partial x} dx = uv\Big|_{-\infty}^{\infty} - \int_{-\infty}^{\infty} v \frac{\partial u}{\partial x} dx$$

$$\cancel{= \int uv}$$

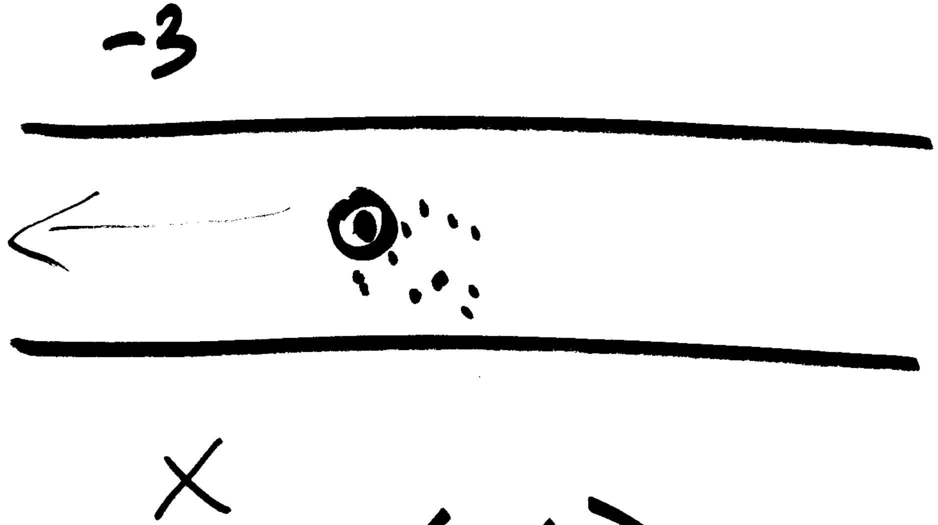
$$\frac{\partial \langle x \rangle}{\partial t} = x \frac{\partial c}{\partial x}\Big|_{-\infty}^{\infty} - D \int_{-\infty}^{\infty} \frac{\partial c}{\partial x} dx$$

$$\frac{\partial}{\partial t}\langle x\rangle = -D\int_{-\infty}^{\infty}\frac{\partial \tilde{c}}{\partial x}\,dx$$

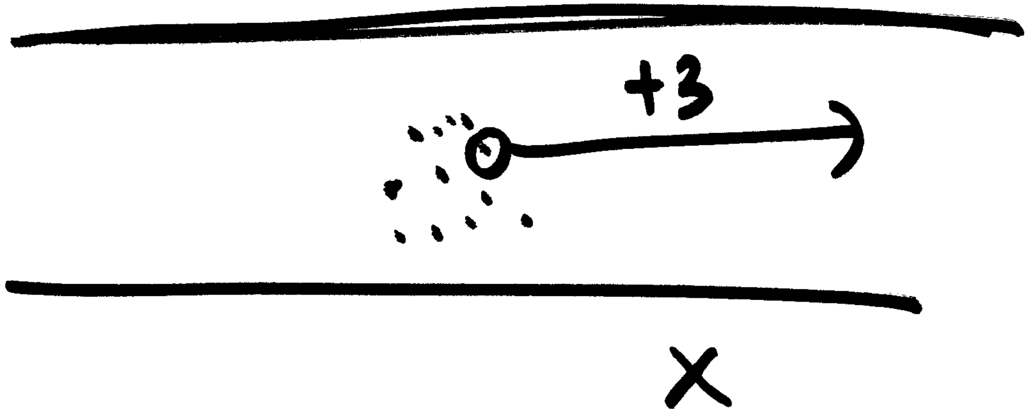
$$= -D\left[c \right]_{-\infty}^{+\infty} = 0$$

$$\langle x \rangle = 0$$

$$\langle x^2 \rangle = 2Dt$$



$$\langle x \rangle = 0$$



$$\langle x^2 \rangle = 2Dt$$

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$$x_{rms} = \sqrt{2Dt}$$

what is D?

$$[D] = \frac{L^2}{T} \quad \text{or} \quad \frac{m^2}{s}$$

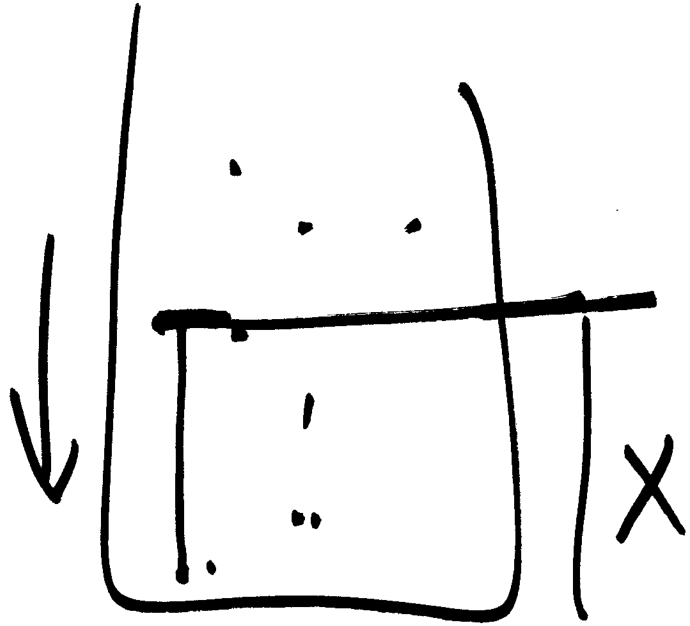
Relation between D, T, η :

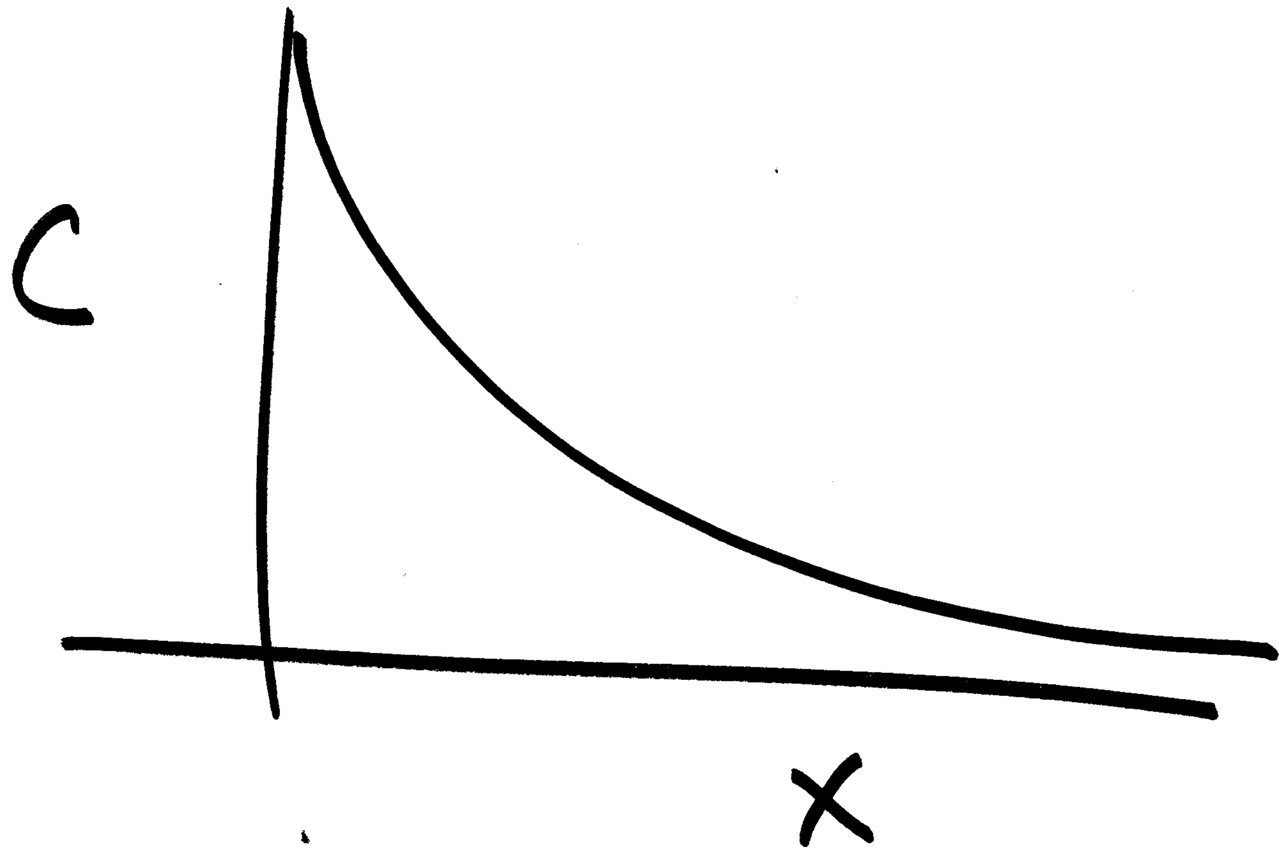
$$\vec{f} = -g\hat{x}$$

$$\vec{f}\cdot\vec{x}$$

$$= -g\hat{x}\cdot x\hat{x}$$

$$= \cancel{-}gx$$





$$\boxed{c \propto e^{-gx/k_BT}}$$

$$C \propto e^{-\frac{gx}{k_BT}}$$

$$\boxed{C = A\, e^{-\frac{gx}{k_BT}}}$$

$$\frac{\partial}{\partial x} e^{kx} = k e^{kx}$$

$$k = -g/k_BT$$

$$J = -D \frac{\partial c}{\partial x}$$

$$\frac{\partial c}{\partial x} = A\, e^{-\frac{gx}{k_BT}} \left(\frac{-g}{k_BT}\right)$$

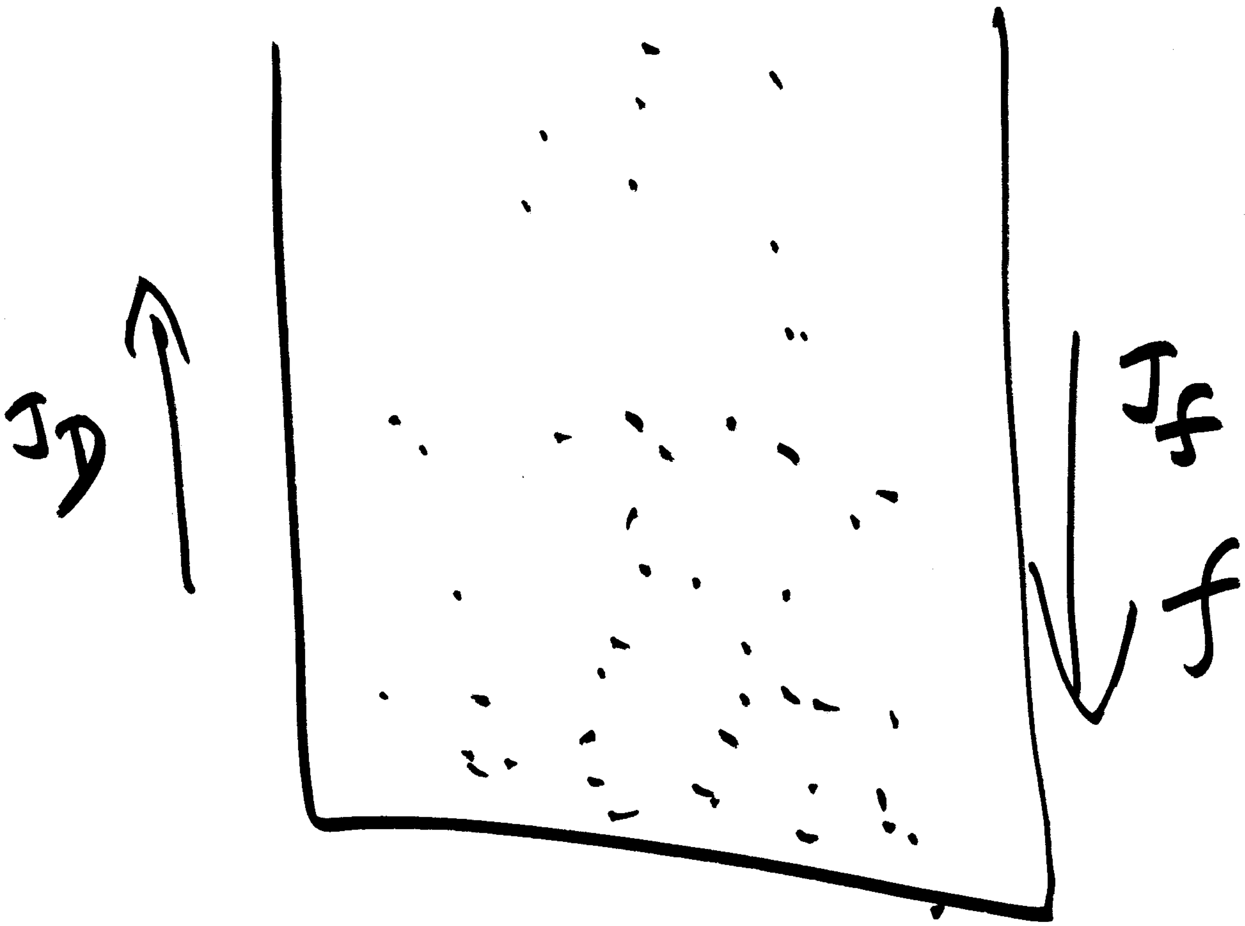
$$J = -D\frac{\partial c}{\partial x} = +\frac{Dcg}{k_BT}$$

$$\Uparrow$$

$$\frac{\partial c}{\partial x} = -\frac{cg}{k_BT}$$

$$\vec{J}_D + \vec{J}_f = 0$$

$$\vec{J}_D = -\vec{J}_f$$



$$J_D = -J_f$$

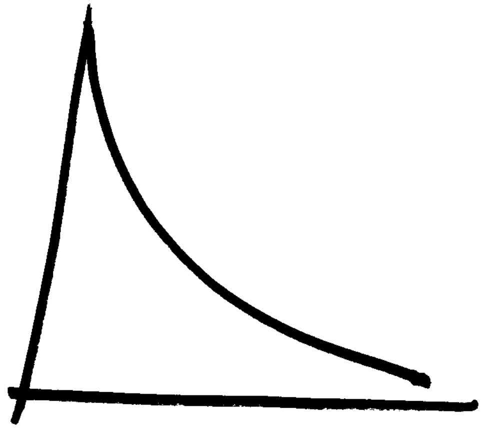
$$\langle x \rangle = 0$$

$$\langle x^2 \rangle = 2Dt$$

$$D = \frac{k_B T}{6\pi\eta a}$$

Diffusion under external field

$$C(x) = A\, e^{-\frac{fx}{k_B T}}$$



free diffusion

$$C(x) = A\, e^{-Bx^2}$$

Guassian

$$\frac{\partial c}{\partial t} = D\frac{\partial^2 c}{\partial x^2}$$

$$\frac{\partial c}{\partial t} = D\frac{\partial^2 c}{\partial x^2} + w\frac{\partial c}{\partial x}.$$

final