$$x(t_n) = x(t_{n-1}) + v_{n-1}\tau + \frac{F\tau^2}{2m}$$

$$\langle x(t_n)\rangle = n\frac{F\tau^2}{2m} = \overbrace{n\tau}^{t_n}\frac{F\tau}{2m}$$

$$\left(x(t_n) - \langle x(t_n)\rangle\right)^2 = \left(x(t_{n-1}) + v_{n-1}\tau + \frac{F\tau^2}{2m} - t_n\frac{F\tau}{2m}\right)^2$$

$$\frac{F\tau^2}{2m} - t_n\frac{F\tau}{2m} = \overbrace{-t_{n-1}\frac{F\tau}{2m}}^{\langle x(t_{n-1})\rangle}$$

$$\frac{F\tau^2}{2m} - n\tau\frac{F\tau}{2m} = \frac{F\tau^2}{2m}(1-n)$$

$$= -\frac{F\tau}{2m}\underbrace{(n-1)\tau}_{t_{n-1}}$$

$$\left\langle \left(x(t_n) - \langle x(t_n) \rangle \right)^2 \right\rangle = \left\langle \left(x(t_{n-1}) + v_{n-1}\tau - \langle x(t_{n-1}) \rangle \right)^2 \right\rangle$$

$$= \left\langle \left(x(t_{n-1}) - \langle x(t_{n-1}) \rangle \right)^2 \right\rangle + \left\langle v_{n-1}^2 \tau^2 \right\rangle$$

$$+ 2 \left\langle \left(x(t_{n-1}) - \langle x(t_{n-1}) \rangle \right) v_{n-1} \tau \right\rangle$$

$$= \left\langle \left(x(t_{n-1}) - \langle x(t_{n-1}) \rangle \right)^2 \right\rangle + v_T^2 \tau^2$$

$$+ 2 \left\langle \left(x(t_{n-1}) - \langle x(t_{n-1}) \rangle \right) \right\rangle \cancelto{0}{\left\langle v_{n-1} \tau \right\rangle}$$

$$\langle (x(t_n) - \langle x(t_n)\rangle)^2 \rangle =$$

$$= \langle (x(t_{n-1}) - \langle x(t_{n-1})\rangle)^2 \rangle + v_T^2 \tau^2$$

$$= \cdots\cdots = \underbrace{\langle (\overbrace{x(t_0)}^{=0} - \overbrace{\langle x(t_0)\rangle}^{=0})^2 \rangle}_{=0} + n v_T^2 \tau^2$$

$$\mathrm{Var}(x(t_n)) = n\tau \; v_T^2 \tau = t_n \frac{\lambda^2}{\tau} = 2D\, t_n$$

$$\langle x(t_n) \rangle = v_d t_n = \frac{F\tau}{2m} t_n$$

$$\mathrm{Var}(t_n) = 2D t_n = \frac{\lambda^2}{\tau} t_n$$

$m \quad \vec{v}_0 \ldots$

$\downarrow \hat{x} \qquad \vec{g}$

$$m a_x = mg - \nu v_x$$

$$\vec{F}_{visc} \uparrow -\nu \vec{v}$$

$$\frac{dv_x}{dt} \to \frac{dv_x}{dt} = 0 \qquad v_x = \frac{mg}{\nu}$$

$$v_d = \frac{F\tau}{2m}$$

$$D = \frac{\lambda^2}{2\tau} = \frac{v_T^2 \tau}{2} \Rightarrow \frac{\tau}{2} = \frac{D}{v_T^2}$$

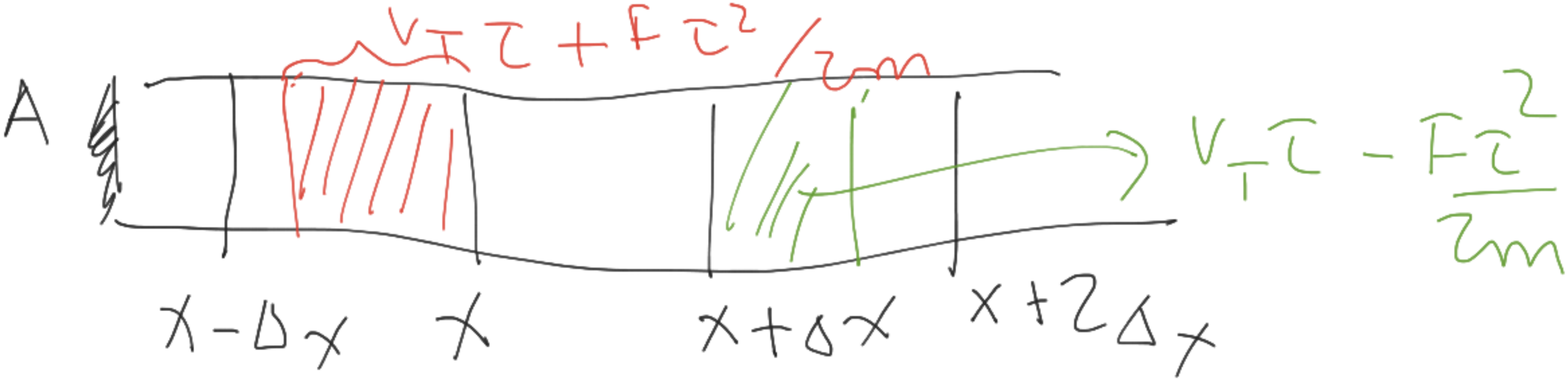
$$v_d = \frac{F D}{m v_T^2} = \frac{F D}{\cancel{m} \frac{k_B T}{\cancel{m}}}$$

$$F = \nu v_d = \frac{k_B T}{D}$$

Einstein

Smoluchowsky

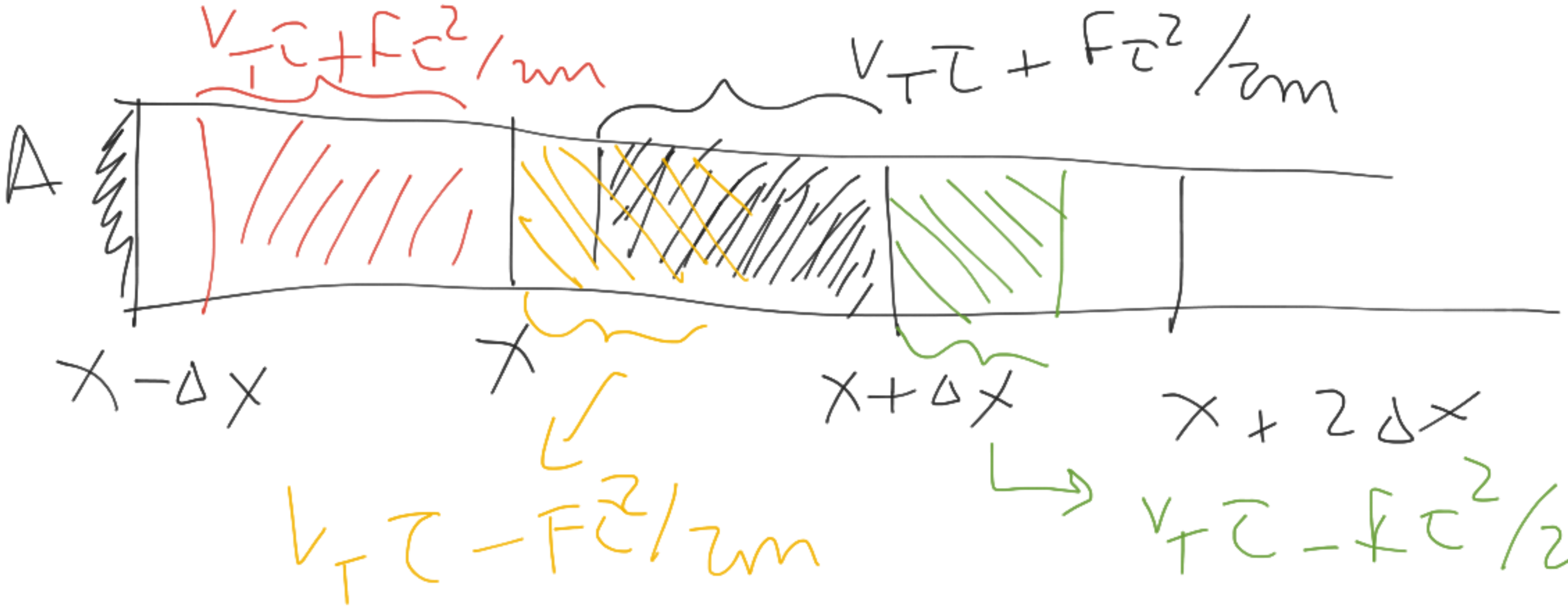
Teo fluktuacji dysypacji



$$x(t_{n+1}) = x(t_n) \pm v_T\tau + \frac{F}{2m}\tau^2$$

$$|x(t_{n+1}) - x(t_n)| = v_T\tau + \frac{F}{2m}\tau^2$$

$$|x(t_{n+1}) - x(t_n)| = \left|-v_T\tau + \frac{F\tau^2}{2m}\right| = v_T\tau - \frac{F\tau^2}{2m}$$



$$n(x, t+\Delta t)\, A\, \Delta x - n(x,t)\, A\, \Delta x$$

$$= \frac{A}{2}\, n(x-\Delta x, t)\left(v_T\tau + \frac{F\tau^2}{2m}\right) + \frac{A}{2}\, n(x+\Delta x, t) \cdot \left(v_T\tau - F\tau^2/2m\right)$$

$$-A\left(\frac{1}{2}\, n(x,t)\left(v_T\tau + \frac{F\tau^2}{2m}\right) + \frac{1}{2}\, n(x,t) \cdot \left(v_T\tau - \frac{F\tau^2}{2m}\right)\right) - n(x,t)\,\Delta x\, A$$

Desarrollo en serie

$$n(x-\Delta x, t) \simeq n(x,t) + \frac{\partial n}{\partial x}(-\Delta x) + \frac{1}{2}\,\partial^2 n/\partial x^2\,(\Delta x)^2$$

$$\frac{n(x,t+\Delta t) - n(x,t)}{\Delta t} \simeq \frac{\partial n}{\partial t}$$

Hamm do la corrente :

$$\frac{\partial n}{\partial t} = D \frac{\partial^2 n}{\partial x^2} - \frac{\partial}{\partial x}(n v_d)$$

$$= -\frac{\partial}{\partial x}\left[-D\frac{\partial n}{\partial x} + n v_d\right]$$

$$\frac{\partial n}{\partial t} = -\frac{\partial}{\partial x}(j_x)$$

$$j = -D\frac{\partial n}{\partial x} - n v_d$$

Si $\vec{F} = q\vec{E}$ $\quad v_d = \frac{F\tau}{2m} = \frac{q\tau E}{2m}$

$$j_{el} = q n v_d = \frac{q^2\tau}{2m} E \to \text{conductividad}$$

$$\frac{\partial n}{\partial t} = \vec{\nabla}\cdot\Big(\underbrace{D\vec{\nabla} n}_{-j_{dif}} - \overbrace{\vec{j}}^{n\vec{v}_d}\Big)$$

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

$$j = -D\frac{\partial c}{\partial x}\bigg|_{x=0}$$

Busco una solución indep del tiempo, estacionaria ; $\frac{\partial}{\partial t} = 0$

$$0 = D\frac{d^2c}{dx^2} - \alpha c$$

$$\frac{d^2c}{dx^2} = +\frac{\alpha}{D}c \quad ; \quad \boxed{c = A e^{-\sqrt{\frac{\alpha}{D}}x} + B e^{+\sqrt{\frac{\alpha}{D}}x}}$$

$$c = e^{\lambda x} \quad ; \quad \frac{dc}{dx} = \lambda c$$

$$\frac{d^2c}{dx^2} = \lambda^2 c = \frac{\alpha}{D}c \rightarrow \lambda = \pm\sqrt{\frac{\alpha}{D}}$$

$$C = A e^{-\sqrt{\frac{\alpha}{D}} x} + B e^{\sqrt{\frac{\alpha}{D}} x}$$

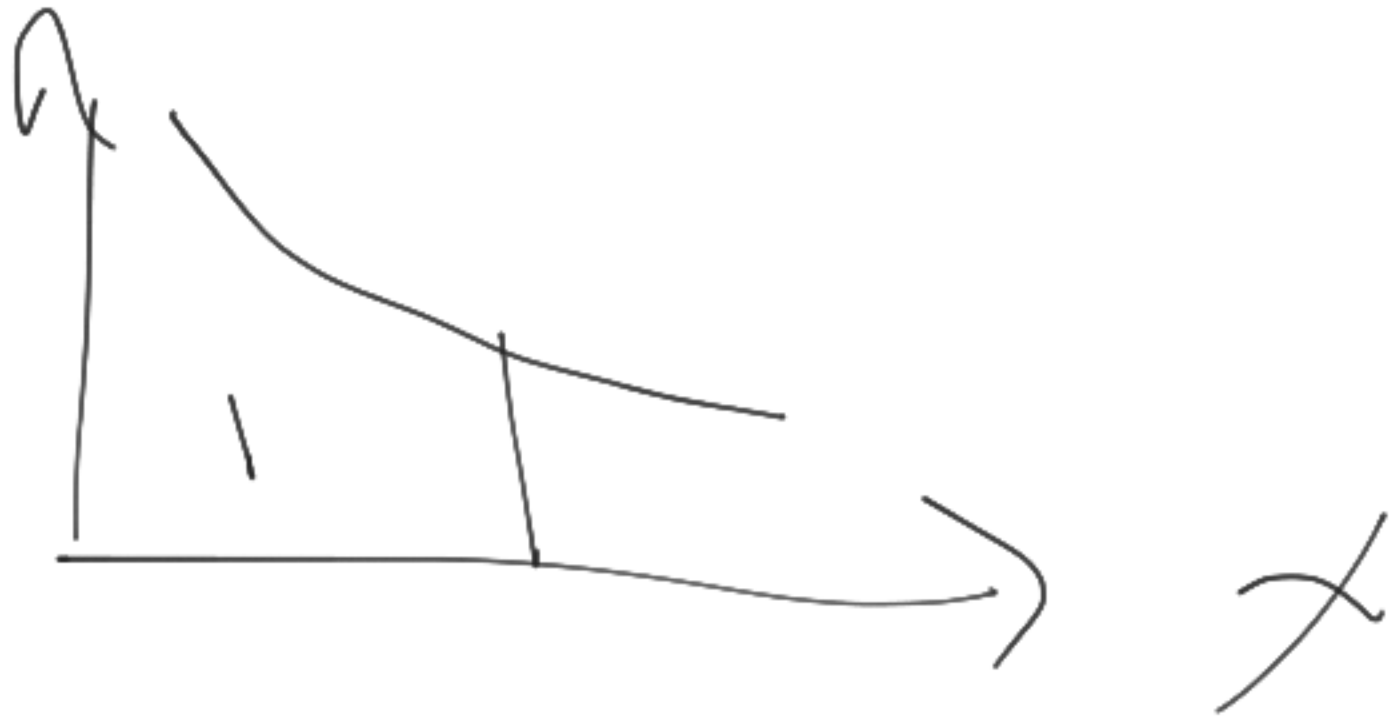
$$\frac{\partial C}{\partial x} = -\sqrt{\frac{\alpha}{D}} A e^{-\sqrt{\frac{\alpha}{D}} x} + B \sqrt{\frac{\alpha}{D}} e^{\sqrt{\frac{\alpha}{D}} x}$$

$$c(x \to \infty) = 0 \quad ; \quad \frac{\partial c}{\partial x}(x \to \infty) = 0$$

$$\Rightarrow B = 0 \qquad \left. -D \frac{\partial c}{\partial x} \right|_{x=0} = j_0 = -\sqrt{\frac{\alpha}{D}} A e^{-\sqrt{\frac{\alpha}{D}} \cdot 0} (-D)$$

$$\Rightarrow A \sqrt{\alpha D} = j$$

$$C = \frac{1}{\sqrt{\alpha D}} e^{-\sqrt{\frac{\alpha}{D}} x}$$



$$\left[\sqrt{\frac{\alpha}{D}}\right] = \frac{1}{[\text{long}]}$$

$$\left[\sqrt{\frac{D}{\alpha}}\right] = [\text{long}]$$

= long caract