04.09.06 1st.

$$m\frac{dx^2}{dt^2} = F$$

$$\updownarrow$$

$$\frac{dx}{dt} \cdot md\left(\frac{dr}{dt}\right) = F \cdot dt + \frac{dx}{dt}.$$

$$\overset{\parallel}{V(x.t)}$$

$$\updownarrow$$

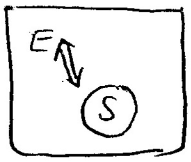
$$V \cdot mdv = F \cdot dx.$$

$$m\int_{V_0}^{V_f} v\,dv + \int_{x_0}^{x_f} (-F)\,dx = 0.$$

$$\underline{m\int_{S_0}^{V_f} v\,dv} + \int_{S_0}^{x_f} (-F)\,dx = \underline{m\int_{S_0}^{V_0} v\,dv} + \int_{S_0}^{x_0} (-F)\,dx.$$

$$m\frac{1}{2}mV_f^2 - m\frac{1}{2}\cancel{m}V_S^2 + \int_{S_0}^{x_f}(-F)\,dx = m\frac{1}{2}V_0^2 - \frac{1}{2}\cancel{m}V_S^2 + \int_{S_0}^{x_0}(-F)\,dx.$$

$$\frac{1}{2}mv^2 + \int -F\,dx = E.$$



$\rightarrow \left[\begin{array}{l} H \\ F \\ G. \end{array} \right.$, F의 관점에서 E 중요

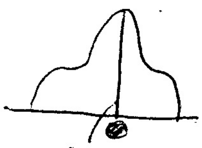
center of mass가 고정.(Newton's) $\xrightarrow{\text{nonsense}}$ (Quantum mechanism)

; single body 든 many body에 속했을 때의 하나 처럼 행동

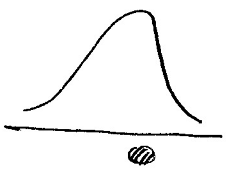
(Na) e e e

$$x_{Na} = \frac{x_1 m_1 + x_2 m_2 \cdots}{m_1 + m_2 + \cdots}$$

coordinate ↑

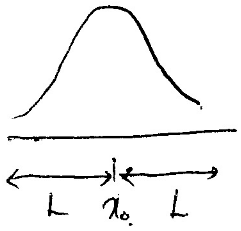


$$\int p(x)\,dx = 1.$$



wave fn 통해 → position
→ 물질의 속성 얻는~.

* wave function reproduction through math. (basiset coefficient 곱의 합으로 표현)



$$f(x) = \sum_K C_K b_K$$

$$= \sum_K C_K \exp\left(\frac{2\pi i}{L} Kx\right)$$

$$\int f(x) \cdot b_K^* = \sum_K C_K \int b_K b_K^* \, dx$$

$$\int_{-L}^{L} f(x) \cdot \exp\left(-\frac{2\pi i}{L} Kx\right) dx = \sum_K C_K \int_{-L}^{L} \exp\left(\frac{2\pi i}{L}(K-K')\right) dx \quad , \ (K=K' \text{ 때에 의미 있음})$$

$$= \frac{L}{2\pi}(K-K')\left[\exp(2\pi(K-K')Li - \exp(2\pi(K-K')\right] \quad (K \neq K' \text{ 경우 } C_K \text{ 찾을수 없음})$$

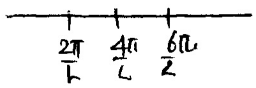
$$= \sum_K \left[\frac{1}{2L} \int f(x) \exp\left(-\frac{2\pi}{L} i \cdot Kx\right) dx\right] \cdot \exp\left(\frac{2\pi i}{L} Kx\right)$$

$L \to \infty$ 때에

$$f(x) = \sum_n C_n \exp\left(\frac{2\pi i}{L} \cdot nx\right)$$

$$C_n = \frac{1}{L} \int_{-\frac{L}{2}}^{\frac{L}{2}} f(x) \exp\left(-\frac{2\pi i}{L} nx\right) dx$$

$\frac{2\pi}{L} n$ (n=정수)

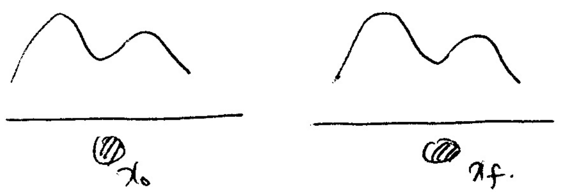


$$f(x) = \frac{L}{2\pi} \int C_K \cdot \exp(Kix) \, dK \qquad \left(n = \frac{L}{2\pi} K \ , \ K = \frac{2\pi}{L} n\right)$$

$$= \frac{L}{\sqrt{2\pi}} \int_{-\infty}^{\infty} \left[\frac{1}{\sqrt{2\pi} L} \int_{-\infty}^{\infty} f(x) \exp(-Kix) dx\right] \exp(Kix) \, dK$$

$$\boxed{\begin{aligned} C_K &= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(x) \exp(-Kix) dx \\ f(x) &= \frac{1}{\sqrt{2\pi}} \int C_K \exp(-iKx) \, dK \end{aligned}}$$

* 시간 고려시. (다시 위의 상황 Fourier Transformation) $\frac{2\pi}{T}=\omega$.



$$f(x,t)=\frac{1}{\sqrt{2\pi}}\int C_k \exp i(kx-\omega t)\,dk.$$

물질 움직일때 wave function도 이동.
$kx-\omega t$의 변화 없어야 함 $\Longrightarrow$

$d(kx-\omega t)=0.$ → 속도 추적 가능.

$$k\,dx=\omega\,dt$$

$$\therefore \frac{dx}{dt}=\frac{\omega}{k}=\frac{\frac{2\pi}{T}}{\frac{2\pi}{L}}=\frac{L}{T}$$

* 물질의 속성 알기위한 $f(x,t)$ 구하기.

$$\boxed{\begin{array}{l} p=\frac{h}{\lambda}\ ,\ E=\nu h \\ (\omega=\frac{2\pi}{T}\ ,\ \frac{1}{T}=\nu). \end{array}}$$

$\hbar=\frac{h}{2\pi}$, $\boxed{p=\hbar k\ ,\ E=\omega\hbar}$ 이 수식을 대입하여 $f(x,t)$ 구함.

$$\Rightarrow f(x,t)=\frac{1}{\sqrt{2\pi}\,\hbar}\int c_k \exp\left(\frac{i}{\hbar}(px-Et)\right)dp$$

$$E=\frac{1}{2}mv^2+\int -F\cdot dx.$$

$$=\frac{p^2}{2m}+\underbrace{\int -F\cdot dx.}_{V(x)}$$

$$\downarrow$$

$$\frac{\partial^2 f(x,t)}{\partial x^2}=\left(\frac{i}{\hbar}\right)^2 p^2 f(x,t).$$

$$-\frac{\hbar^2}{2m}\cdot\frac{\partial^2 f(x,t)}{\partial x^2}=\frac{p^2}{2m}f(x,t)$$

$$\frac{p^2}{2m}f(x,t)\Longrightarrow\left[-\frac{\hbar^2}{2m}\cdot\frac{\partial^2}{\partial x^2}\right]f(x,t)$$

$$\left[-\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}+V(x)\right]f(x,t)=\left[\frac{p^2}{2m}+V(x)\right]f(x,t).$$

$$=E\cdot f(x,t).$$

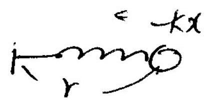
$$\frac{\partial f(x,t)}{\partial x}=\frac{i}{\hbar}p\cdot f(x,t).$$

$$\frac{\hbar}{i}\frac{\partial f(x,t)}{\partial x}=p\cdot f(x,t).$$

momentum
끌어내는 연산자.

*

$+q$ — r — e^- $\qquad V=\int_s^r -\frac{qe}{4\pi\varepsilon_0|r|^2}(-F).=-\frac{qe}{4\pi\varepsilon_0 r}$



$$V=\int_0^x -(-kx)\,dx=\frac{1}{2}kx^2$$

$$\therefore V(r)=\int -F\cdot dr.$$