* 1D osziladore harmonikoa

hamiltondarraren adierazpen klasikoa

$$h(q,p) = \frac{1}{2}Kq^2 + \frac{1}{2m}p^2$$

$$\omega = \sqrt{\frac{K}{m}}$$

$$E = \frac{1}{2}m\omega^2A^2$$

$$\begin{cases} q \equiv A\cos(\omega t+\varphi) \\ p \equiv m\dot{q} = -m[\omega A\sin(\omega t+\varphi)] \end{cases}$$

Mekanika

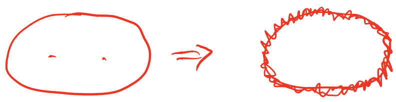
*ω !!

$$\Downarrow$$

$$\boxed{\frac{q^2}{\left(\frac{2E}{m\omega^2}\right)} + \frac{p^2}{(2mE)} = 1}$$

fase-espazioko ibilbidea

interpretazioa E = konstante



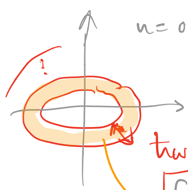
E=kte $\qquad$ $E-\frac{1}{2}\Delta \leq E \leq E+\frac{1}{2}\Delta$

$\Downarrow$ $\qquad$ zabalera? $\qquad$ $\Downarrow$

$$\frac{2\pi E}{\omega} \qquad\qquad \frac{2\pi\Delta}{\omega}$$

$$E_n = \left(n+\frac{1}{2}\right)\hbar\omega \qquad \omega = \sqrt{\frac{K}{m}}$$

$n = 0, 1, 2, \ldots \infty$



$\hbar\omega \equiv$ quantua

$$\boxed{\left[\left[\frac{2\pi\Delta}{\omega}\right] \quad \Delta = \hbar\omega\right] \equiv h}$$

multzokideek egon behar dute elipsearen perimetroan

Heisenberg-en ziurgabetasun printzipioa

$$\boxed{\omega_0 \equiv h^N}$$