PHYS 311 Lecture 7 14. 10. 2024

Proper Time Calculations

Constant force motion

$$\vec{u} = \frac{c\hat{\imath}\,\theta}{\sqrt{1+\theta^2}}$$

$$\vec{F} = F_0\hat{\imath} \; ; \; \vec{u}(0) = 0$$

$$\theta = \frac{F_0 t}{m_0 c^2}$$

$$\frac{m_0 c^2}{F_0}\theta = t$$

$$\tau = \int_0^t dt\sqrt{1-u^2(t')/c^2}$$

$$= \frac{m_0 c^2}{F_0}\int_0^\theta d\theta\sqrt{1-\frac{\theta^2}{1+\theta^2}}$$

$$= \frac{m_0 c^2}{F_0}\int_0^\theta \frac{d\theta'}{\sqrt{1+\theta'^2}}$$

$\Downarrow$ Substitution:

$$\theta' = \sinh u \qquad d\theta' = \cosh u\, du$$

$$\tau = \frac{m_0 c^2}{F_0}\int_0^u \frac{d(\sinh u)}{(\cosh u)} = \frac{m_0 c^2}{F_0}\int du$$

$$= \boxed{\frac{m_0 c^2}{F_0}\,\mathrm{Arcsinh}(\theta)}$$

$\Downarrow$

$$\boxed{\sinh\left(\frac{F_0 \tau}{m_0 c^2}\right) = \frac{F_0 t}{m_0 c^2}}$$

as $\tau \to$ Large: $\left(\frac{F_0\tau}{m_0 c^2}\right)$

$$\boxed{\frac{e^{\frac{F_0 \tau}{m_0 c^2}}}{2} = \frac{F_0 t}{m_0 c^2}}$$

Remember

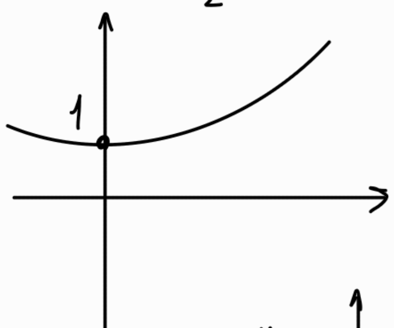
$$\cosh^2 u - \sinh^2 u = 1$$

$$\frac{d\cosh u}{du} = \sinh u$$

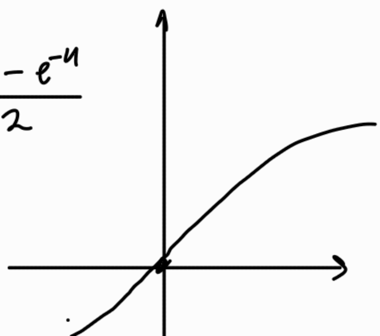
&

$$\frac{d\sinh u}{du} = \cosh u$$

$$\cosh u = \frac{e^u + e^{-u}}{2}$$



$$\sinh u = \frac{e^u - e^{-u}}{2}$$



Kopenhagen Interpretation of Quantum Physics

+ in classical p. "given an observable quantity x and y, what is the final condition?"
+ in quantum p. "... what is the probability..."

- Most ideas remain, their shape changes! Like in relativity.

→ When you define a system, you define it precisely.

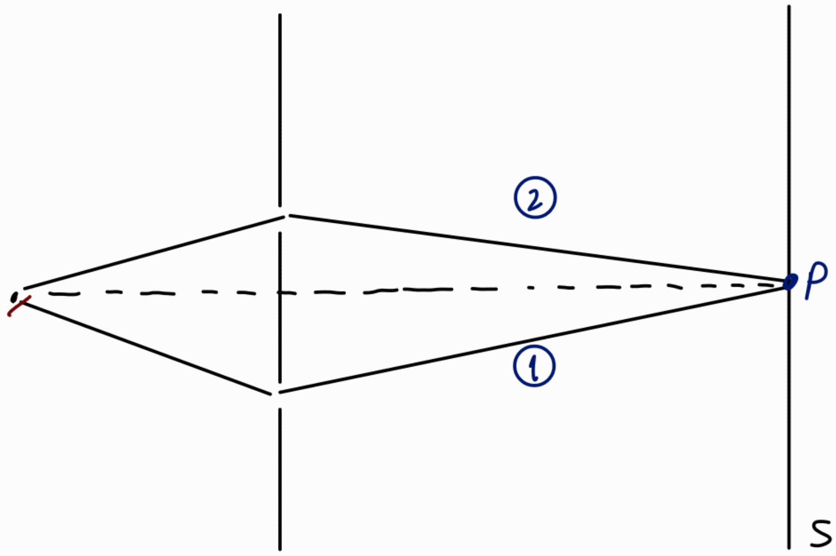
"When you play backgammon, you throw a dice, so there is probability. But faces of the dice won't change"

- You have observibles in both... In QP state is just the state, state is not directly observable. You use the state as an object to measure the observables.

"Something is squared, but before that, something is added."

state

Double Slit Experiment



Keep in mind there are other paths as well.

$$A_{①} + A_{②} = A_{Ⓟ}$$

$$P = |A_{Ⓟ}|^2$$

You are <u>NOT</u> adding probabilities

- "wave particle unity"

"feynman path integral"

- Classical state is undefinable for quantum object.

A state exist, it's not observible