Today

I. Last Time
II. Wrap up of Extended Example of Relativistic Energy-Momentum Conservation: Suggestions for Relativistic particle problems
III. Last Comments on Relativity
IV. Complex Numbers

I. Yanpei Deng will help in the lab. She's available MTuW from 7-8pm in Brody lab.

Antu Antu will be providing homework support. Possible hours are: Tu 8-9pm, Th10:30-11:30am, Th 8-9pm.

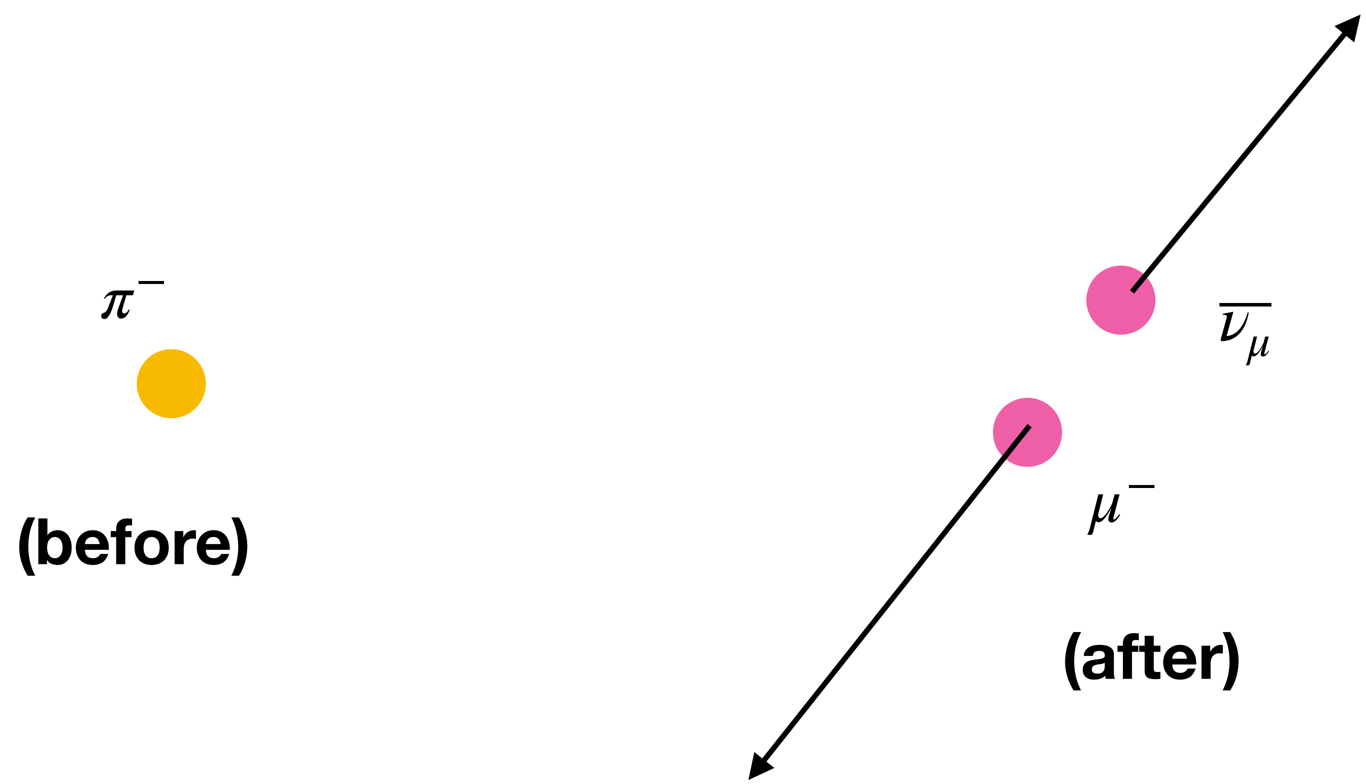
Hw due: Thursday 10pm

Lab Reports now due: Saturday 5pm.

First exam is a take-home exam, it will be posted this Friday and be due the following Thursday at 10pm.

I. Last Time

Last time we were discussing the decay of a pion into a muon and anti-muon neutrino.



We found that $E_\mu = \dfrac{m_\pi^2 c^2 + m_\mu^2 c^2}{2m_\pi}$.

Can we also find the muon's momentum? What about its speed?

II. Let's do the momentum:

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$$|\vec{p}_\mu| c = \sqrt{E_\mu^2 - m_\mu^2 c^4} = \sqrt{\left(\frac{m_\pi^2 c^2 + m_\mu^2 c^2}{2m_\pi}\right)^2 - m_\mu^2 c^4}$$

$$= \sqrt{\frac{m_\pi^4 c^4 + m_\mu^4 c^4 + 2m_\pi^2 m_\mu^2 c^4 - 4m_\pi^2 m_\mu^2 c^4}{4m_\pi^2}}$$

$$= \sqrt{\left(\frac{m_\pi^2 c^2 - m_\mu^2 c^2}{2m_\pi}\right)^2} = \left(\frac{m_\pi^2 c^2 - m_\mu^2 c^2}{2m_\pi}\right)$$

Suggestion 1: To get the E of a particle given its $\vec{p}$ (or vice versa) use the invariant.

II. Let's also find the velocity of the muon.

Recall $E = \gamma mc^2$ and $\vec{p} = \gamma m \vec{v}$, notice that if we take the ratio we have

$$\frac{\vec{p}}{E} = \frac{\gamma m \vec{v}}{\gamma mc^2} = \frac{\vec{v}}{c^2} \quad \text{or } \vec{v} = \frac{\vec{p}c^2}{E}.$$

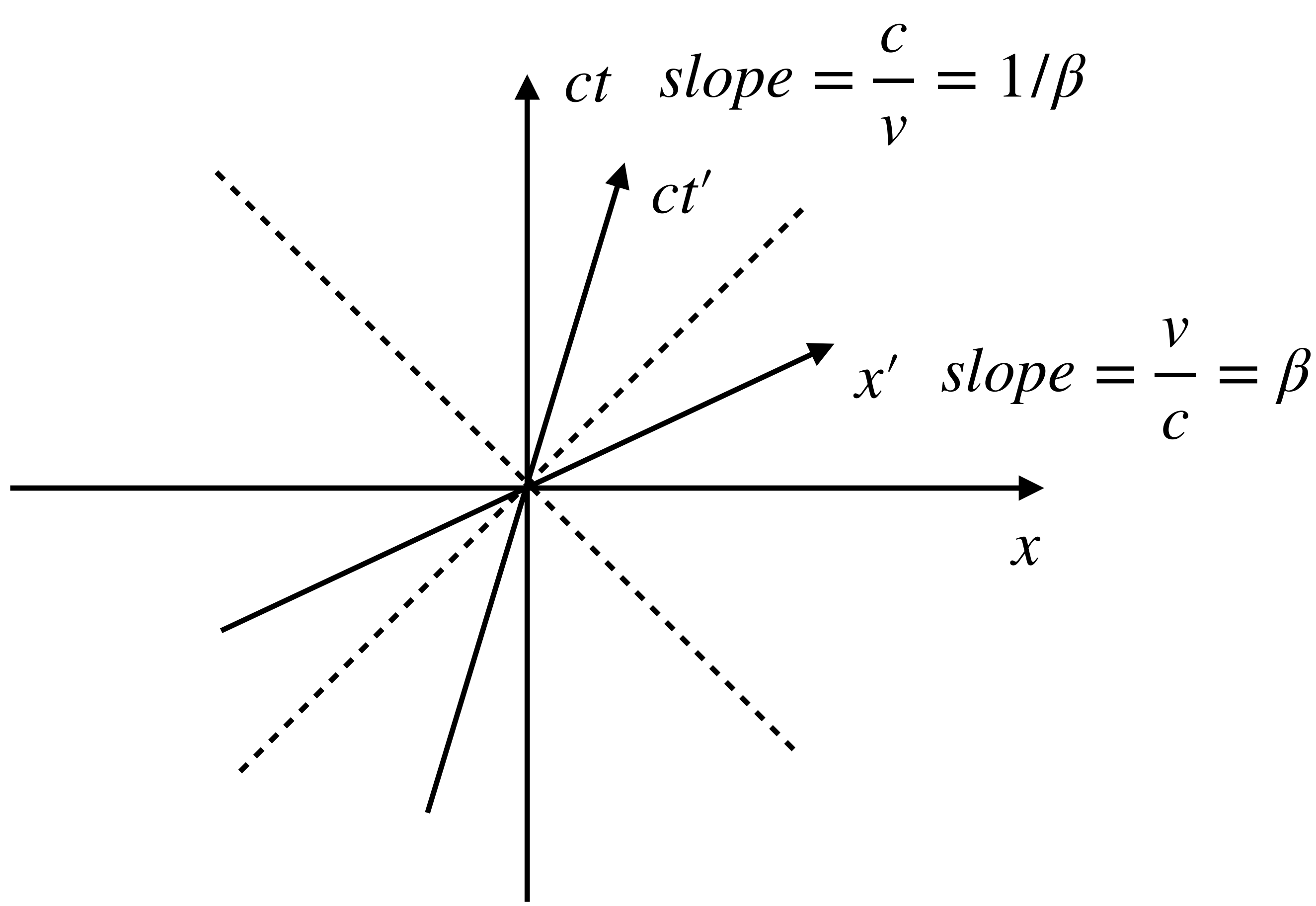
Let's do it for our muon

$$|\vec{v}_\mu| = \frac{|\vec{p}_\mu|c^2}{E_\mu} = \frac{\left(\frac{m_\pi^2 c^3 - m_\mu^2 c^3}{2m_\pi}\right)}{\frac{m_\pi^2 c^2 + m_\mu^2 c^2}{2m_\pi}} = \frac{m_\pi^2 - m_\mu^2}{m_\pi^2 + m_\mu^2} c.$$

Suggestion 1: To get the E of a particle given its $\vec{p}$ (or vice versa) use the invariant.

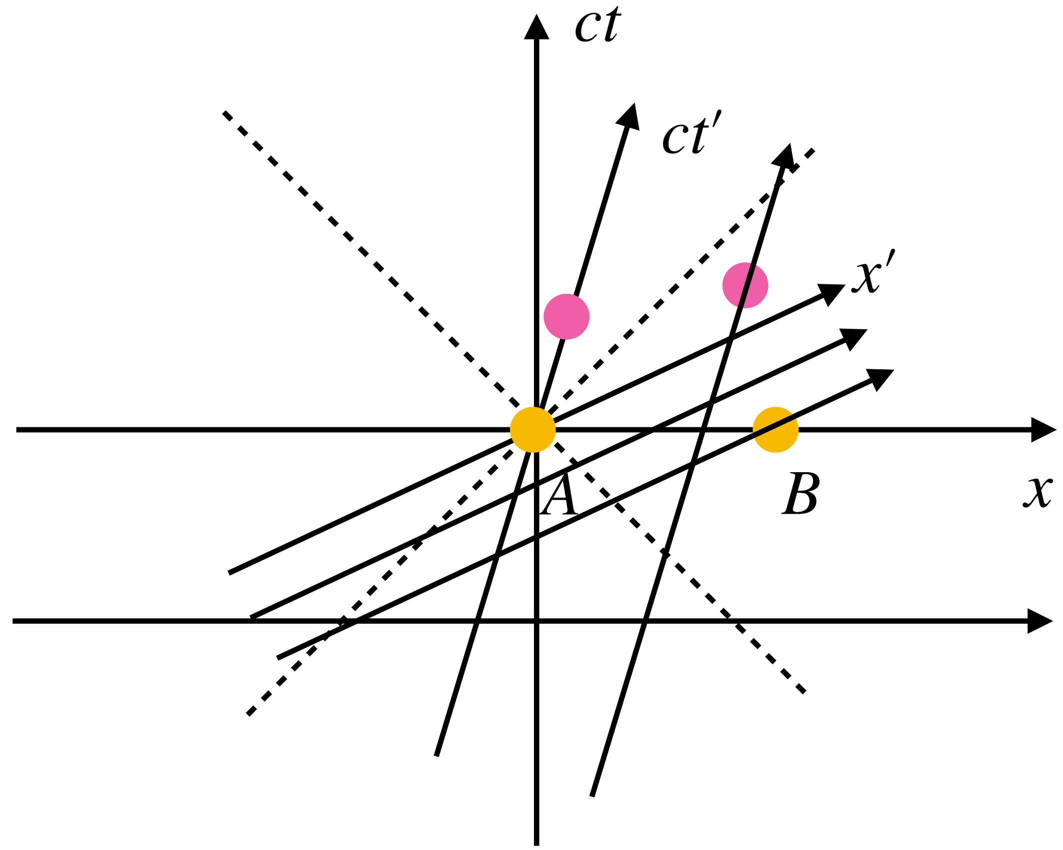
Suggestion 2: If you know E and $\vec{p}$ of a particle and you want $\vec{v}$, then use $\vec{v} = \vec{p}c^2/E$.

III. Last comments on relativity



This gives us a graphical way to understand the two lights problem with the relativistic train.

III. Last comments on relativity

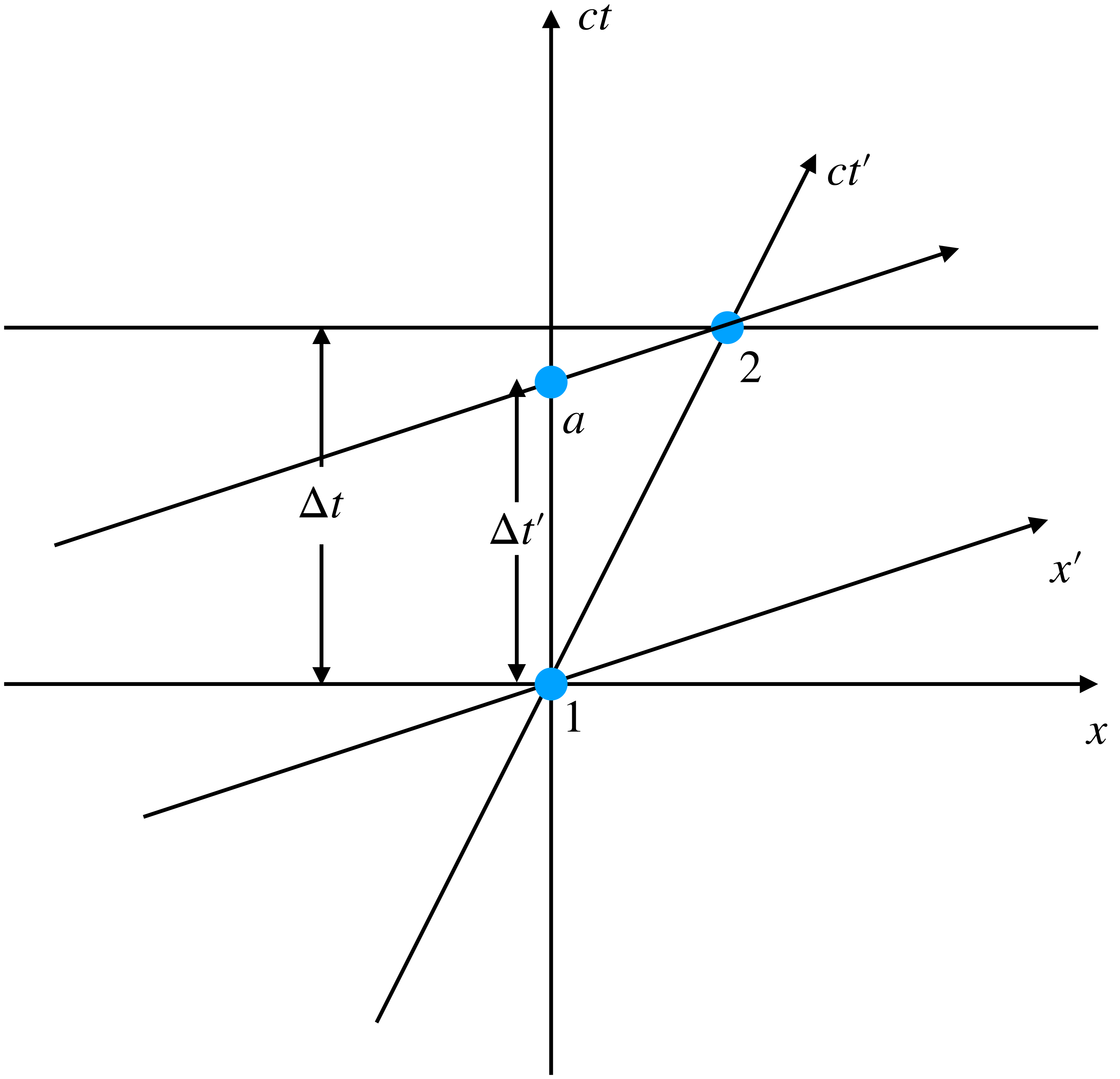


This gives us a graphical way to understand the two lights problem with the relativistic train.

$\Delta s^2 = -c^2 \Delta t^2 + \Delta x^2$ (note strange minus again)

To find the coordinates of an event in any frame, we take parallels to the axes, move them to the events and follow them back to the axes.

III. Time dilation in diagrams:



$$\Delta t = \gamma \Delta t'$$