Invariance of distances transverse to motion

The light clock and TIME DILATION (in class and in tutorial 2)

IN CLASS

TUT 2

PS3 Q1

LORENTZ TRASFORMATIONS

TUT 3

LENGTH CONTRACTION

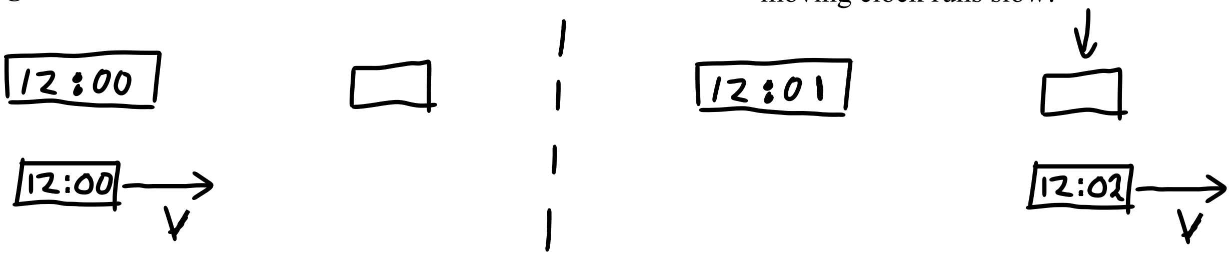
The invariant interval
Spacelike, timelike, null, proper length and proper time

Visualize it all: spacetime diagrams

Different ways to do one clicker question - the third (last) question from lecture 5

1. **Change frame of reference** and use time dilation:

Must be more than 12:02 since the moving clock runs slow!



2. Use **Lorentz Transformations**

$$\tilde{x} = \gamma(x + vt)$$
$$\tilde{t} = \gamma\left(t + \frac{v}{c^2}x\right)$$

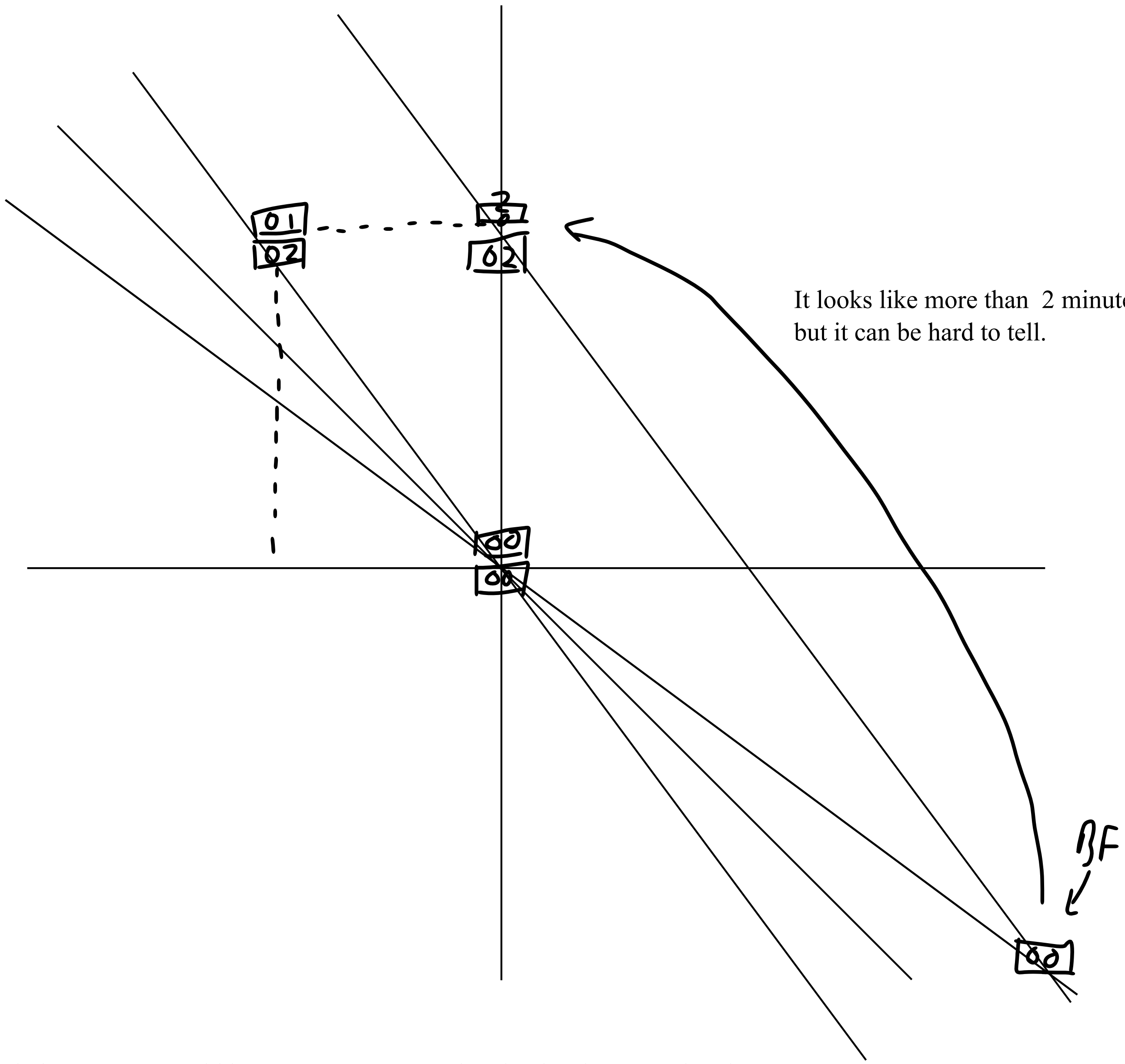
Event 1: $x = 0$, $t = 0$, $\tilde{x} = 0$, $\tilde{t} = 0$

Event 2: $x = -D$, $t = 2$, $\tilde{x} = 0$, $\tilde{t} = 1$

Event 3: $x = 0$, $t = 2$, $\tilde{x} = ?$, $\tilde{t} = ?$

$$\tilde{t} = \gamma\left(2 + \frac{v}{c^2}0\right) = 2\gamma > 2$$

3. Draw a **spacetime diagram** (accurately - this can be difficult)



It looks like more than 2 minutes, but it can be hard to tell.

To do better, you would have to compute v and make the slopes on the plot more accurate
Lesson: accurate spacetime diagrams are better than inaccurate ones! bring a ruler.

4. Use the **invariant interval**

In Anne's frame of reference, s between the event where her clock shows 12:00 and her clock shows 12:02 is
$s^2 = (2\text{ min})^2 c^2$

In Bart's frame of reference, this is
$s^2 = (t\text{ min})^2 c^2 - D^2$
Where D is the distance from Bart to BF and t is the time we want. We get that t > 2 min, so the answer must be 12:04.

Additional aside:

$$0 = \gamma(-D + v \cdot 2) \quad / \cdot (-v)$$
$$1 = \gamma\left(2 + \frac{v}{c^2}(-D)\right) \quad / \cdot c^2$$
$$+ \quad c^2 = -2\gamma v^2 + 2\gamma c^2 = 2\gamma c^2\left(1 - \frac{v^2}{c^2}\right)$$
$$1 = 2\gamma \frac{1}{\gamma^2} \Rightarrow \gamma = 2$$