

The “Paradoxes” of Special Relativity



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MICA (www.mica-vw.org)

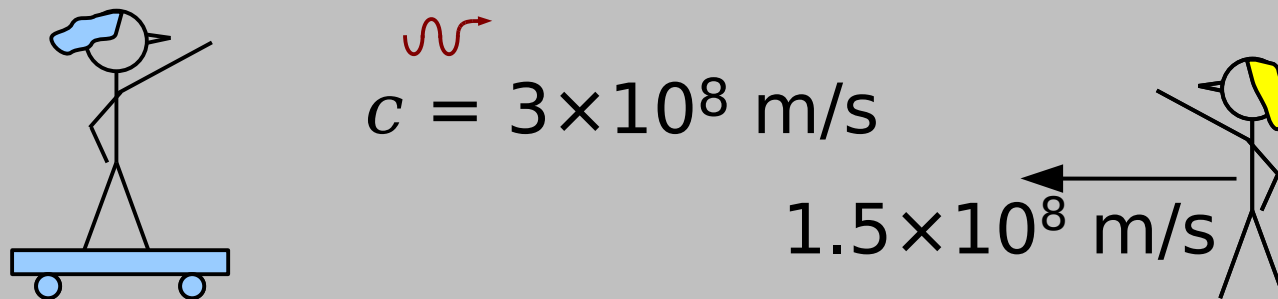
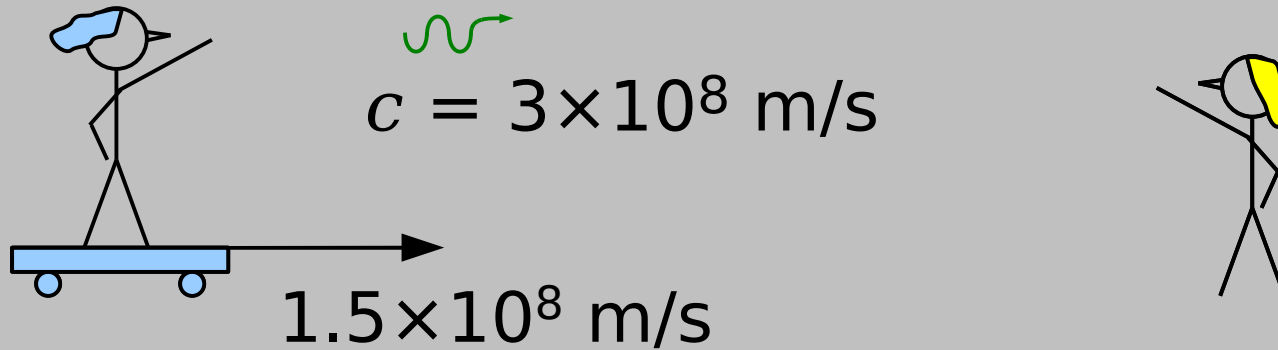
Second Life, 2010-05-08

The two postulates of Special Relativity

1. The laws of physics are the same for every inertial observer.
2. The speed of light in a vacuum is an absolute constant, the same for every inertial observer.

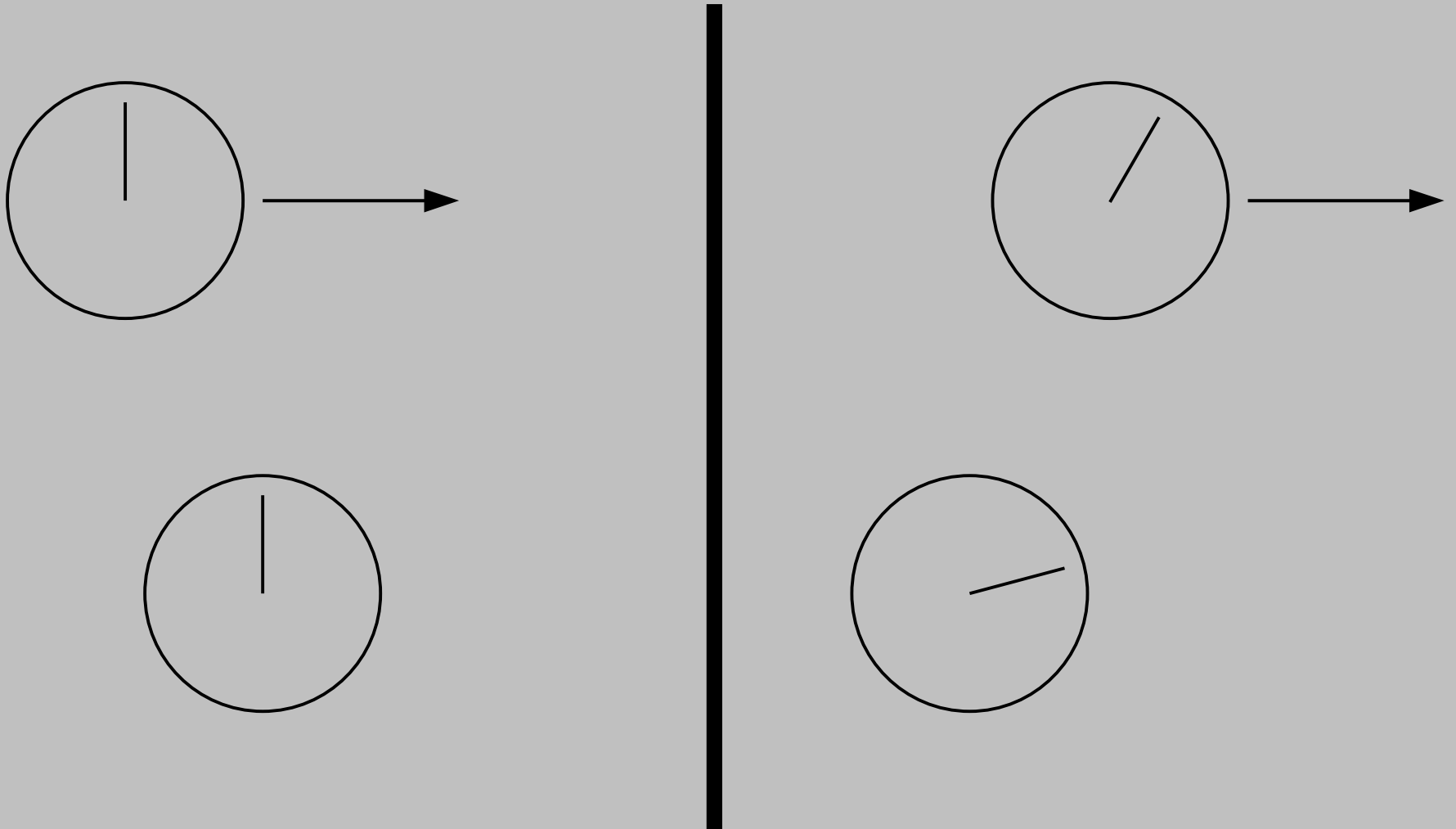
“inertial” = not accelerating, not in a gravity field

Special Relativity : the speed of light in a vacuum is the same as measured by any observer.



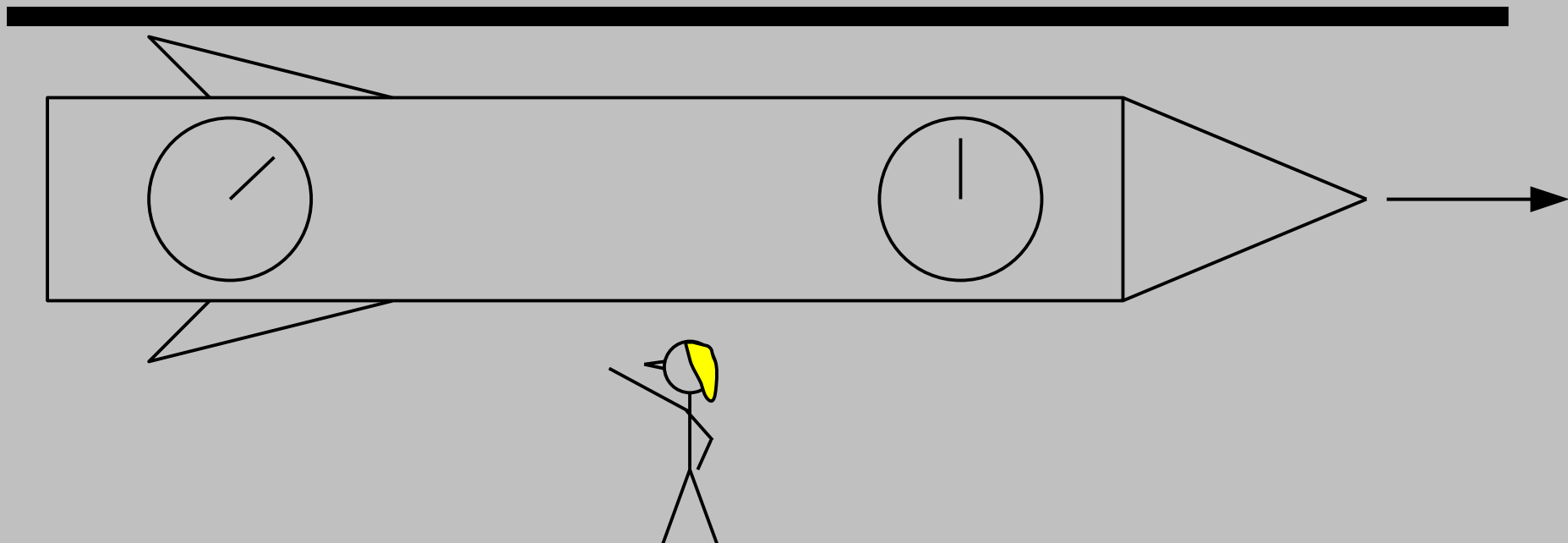
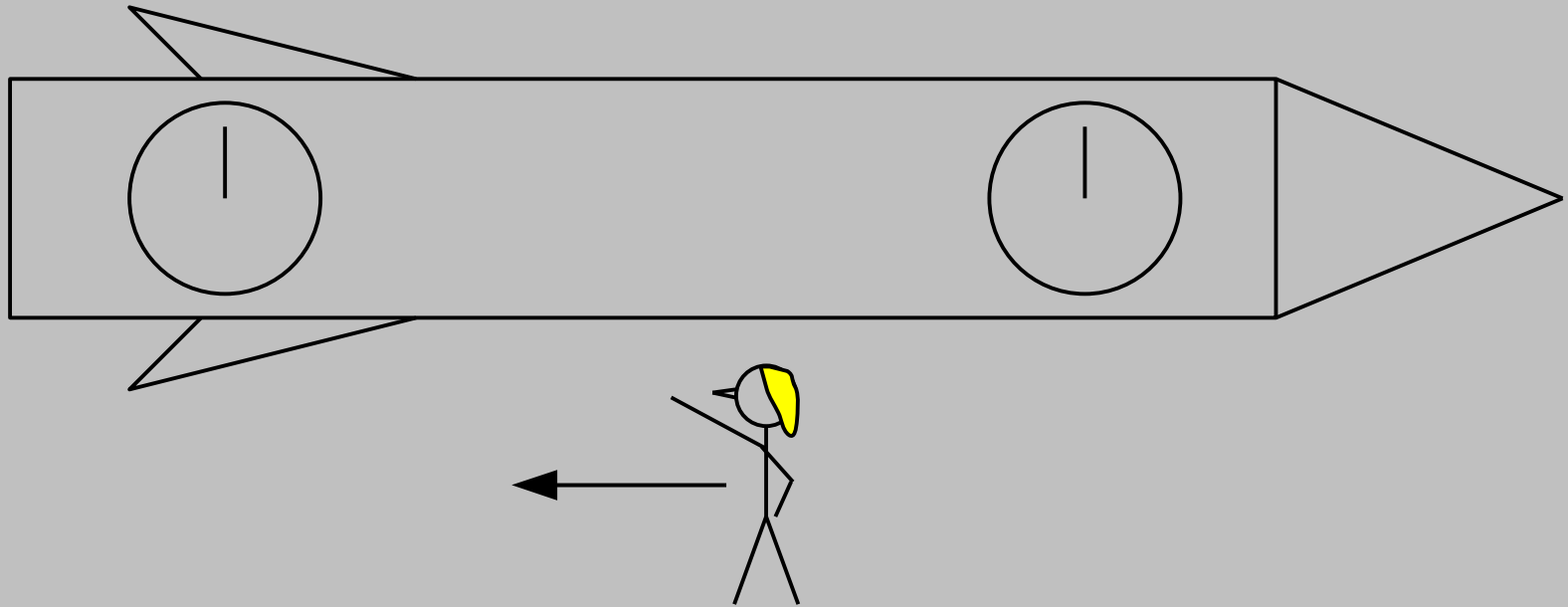
It's not intuitive, but it's true... *and it has consequences.*

SR Effect #1 : Time Dilation



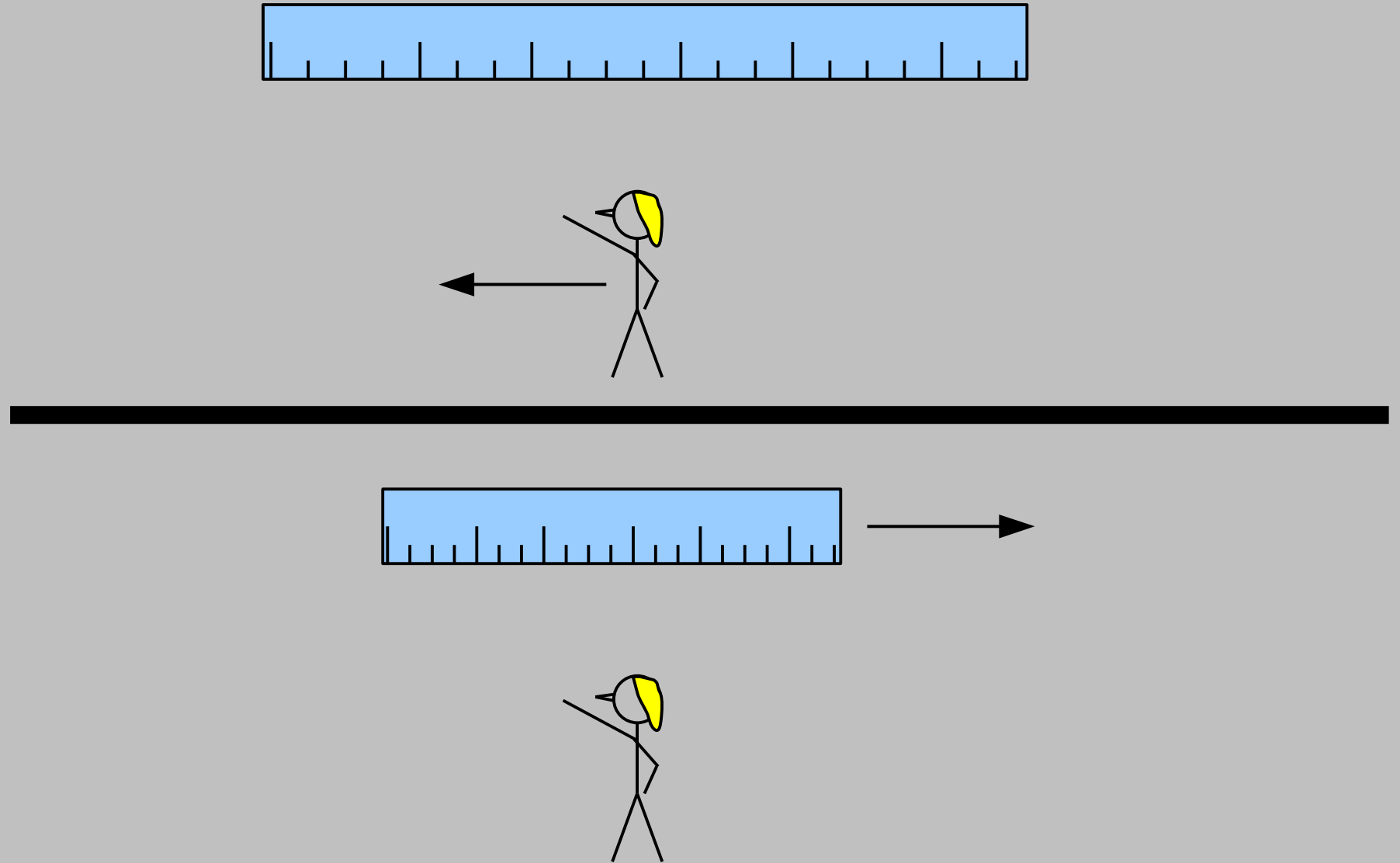
Moving clocks run slow.

SR Effect #2 : Simultaneity



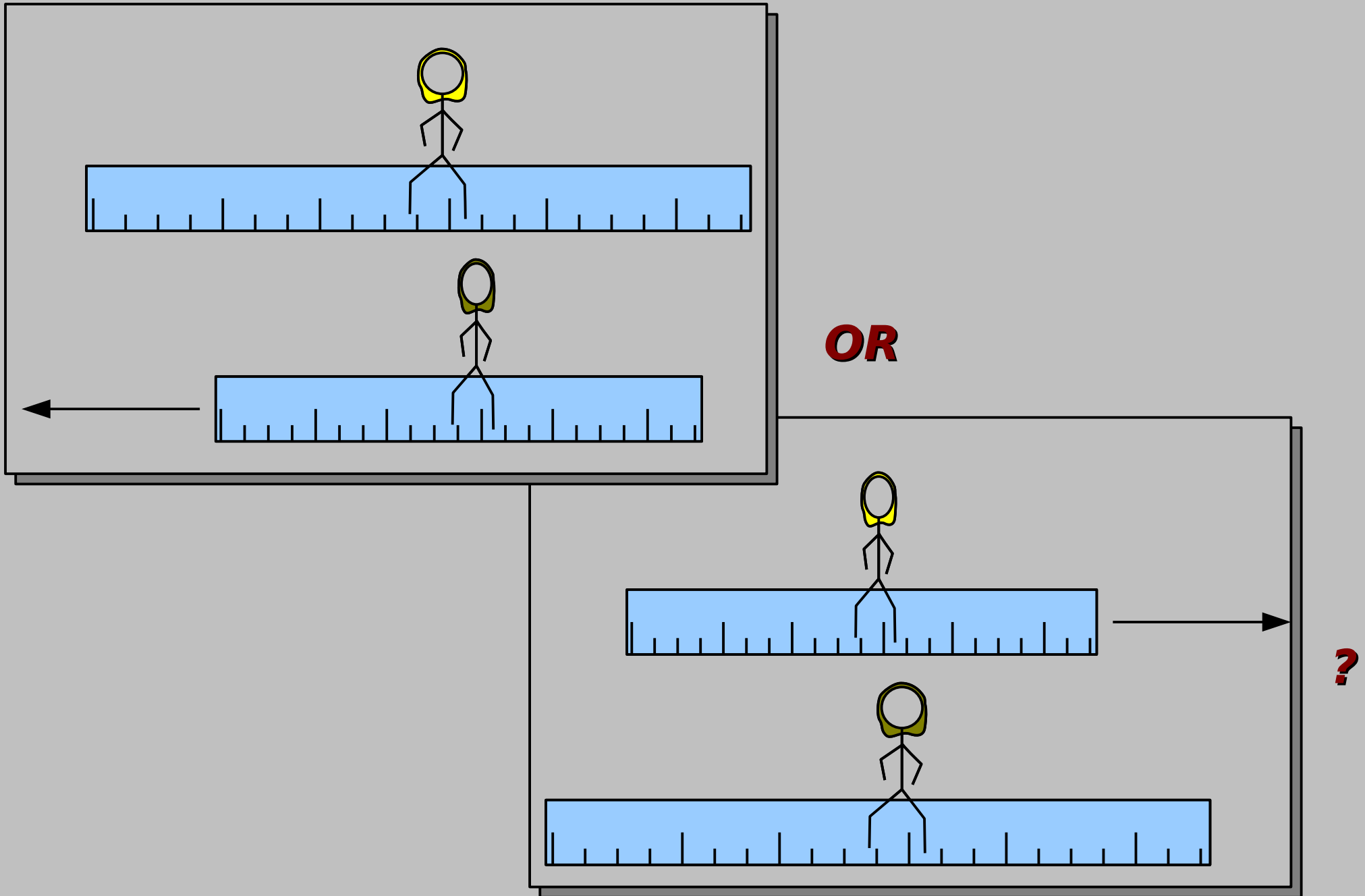
Clocks synchronized in one frame aren't in another
(leading clocks lag).

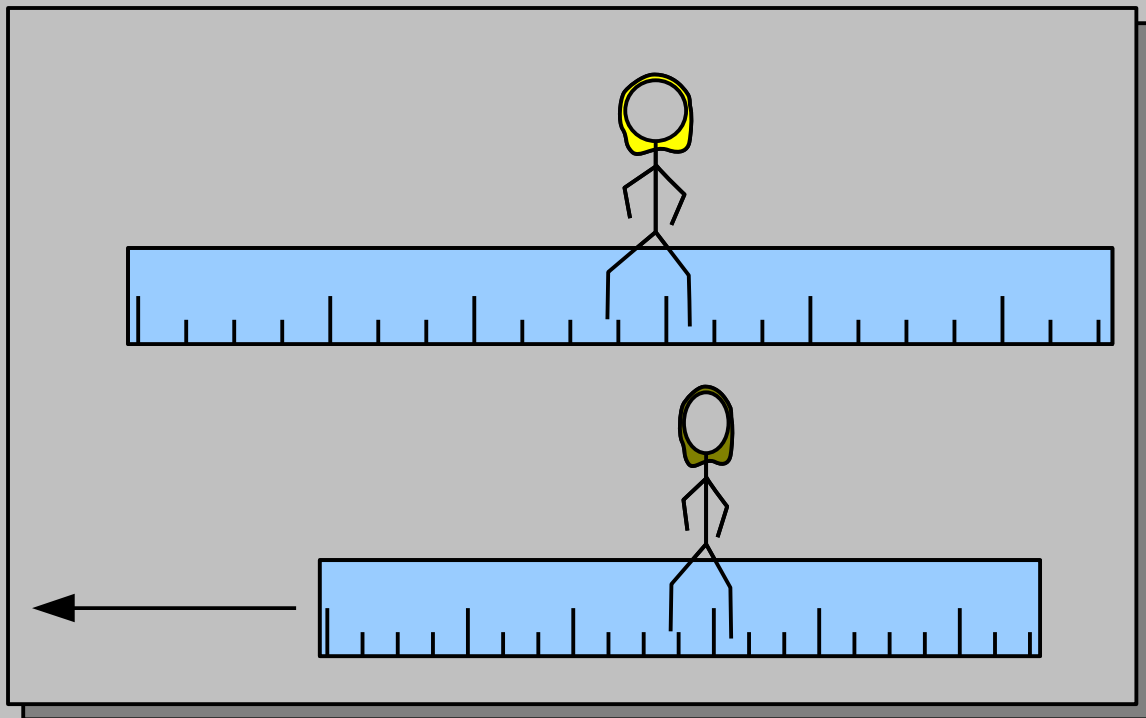
SR Effect #3 : Lorentz Contraction



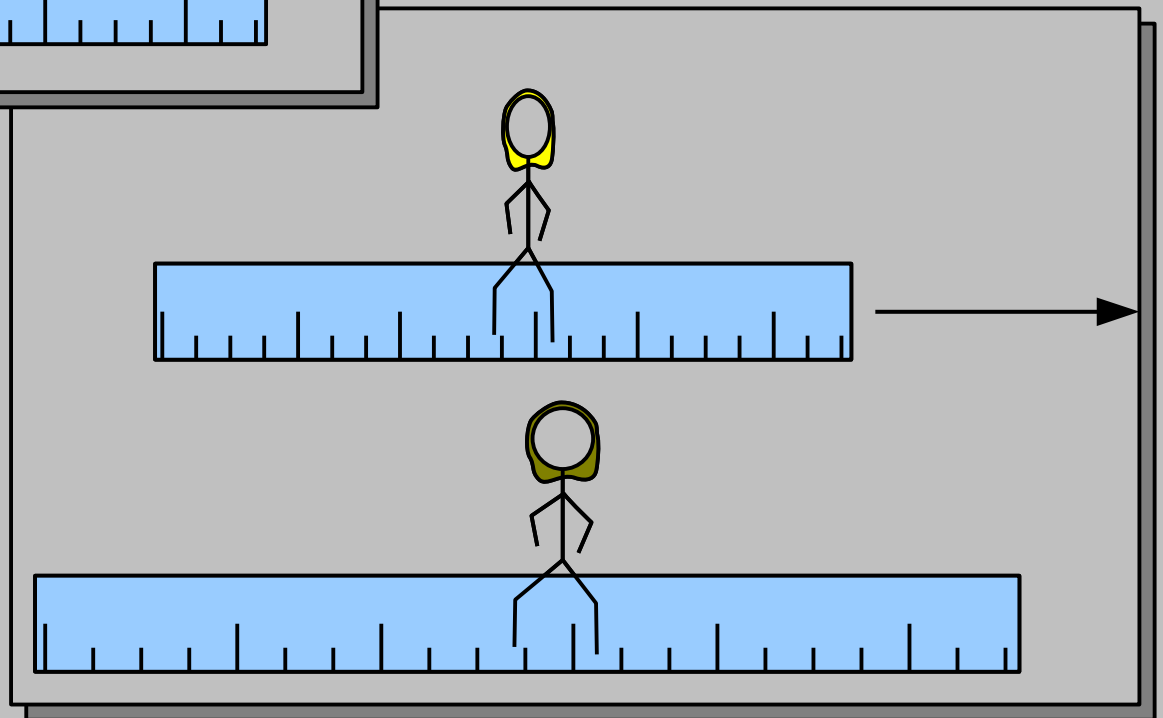
Moving objects *are* shorter along the direction of motion

If any frame of reference is as good as any other...
who is “really” *moving*?

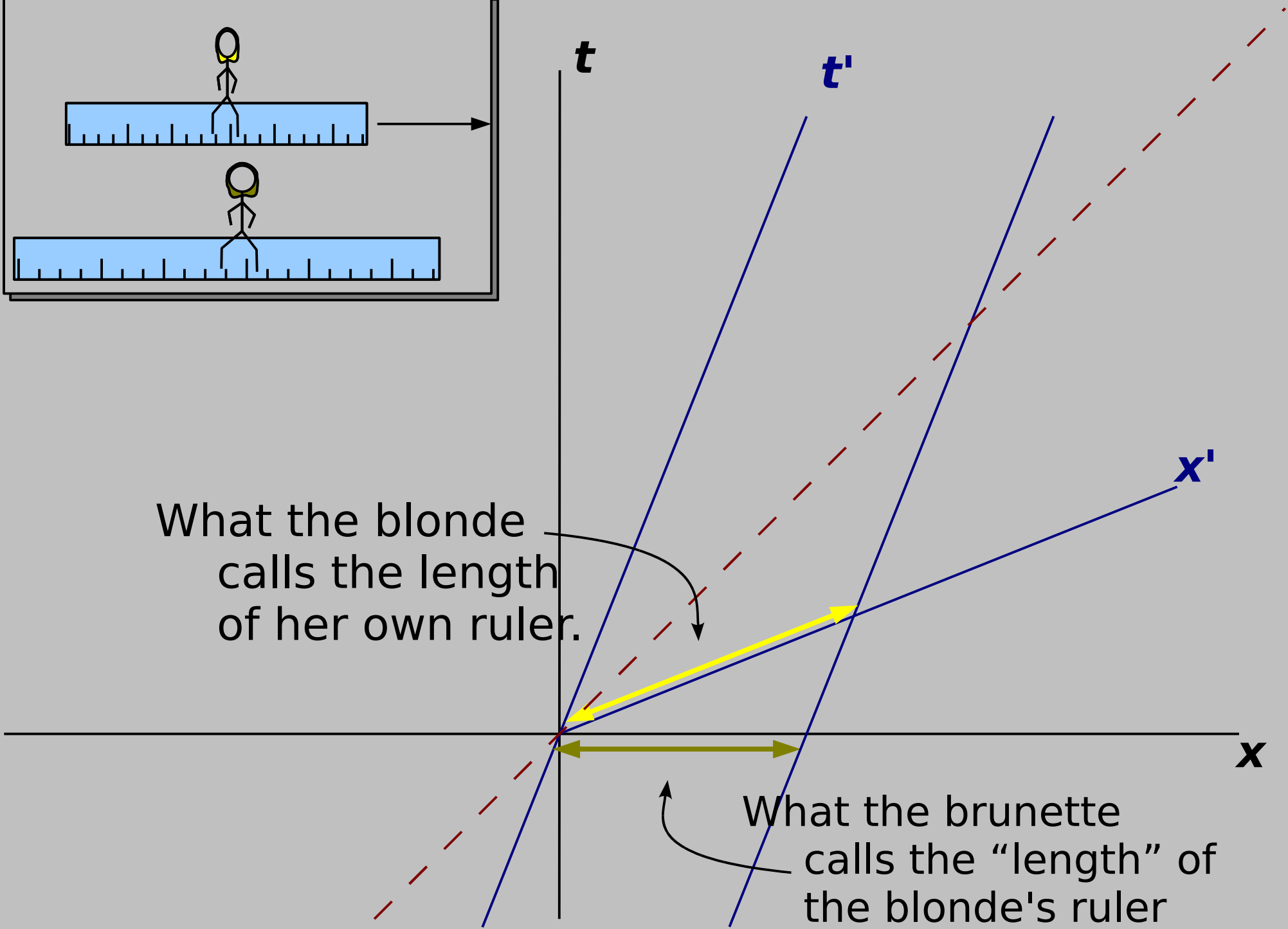
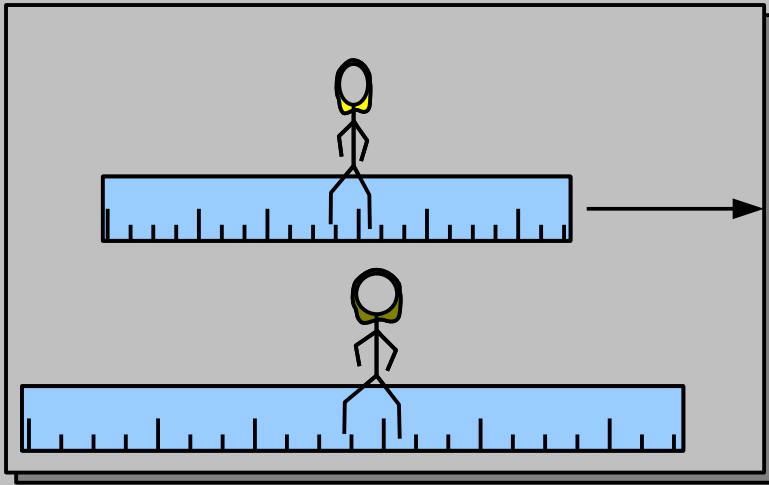




OR



Answer: *both* are right!



What the blonde
calls the length
of her own ruler.

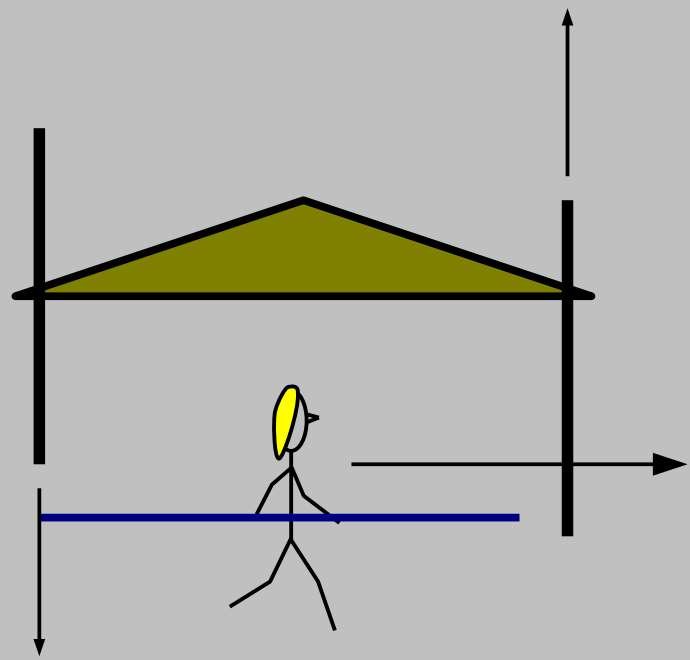
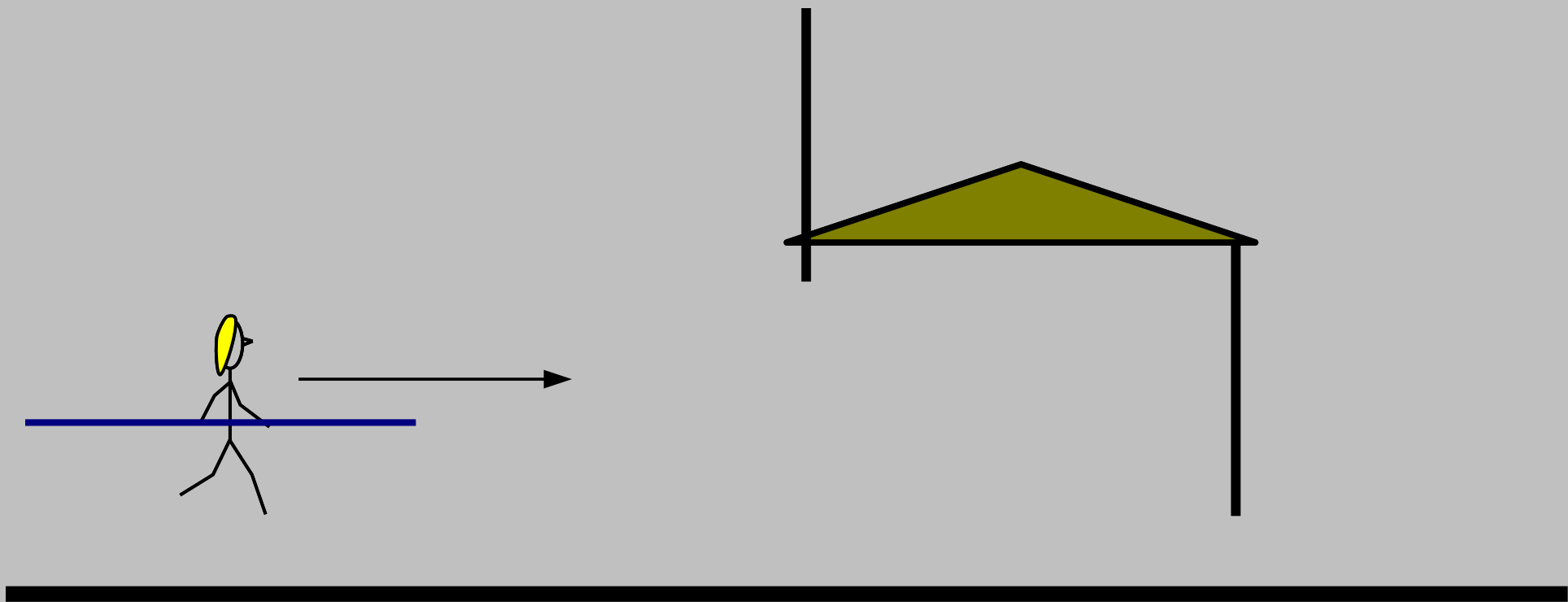
What the brunette
calls the "length" of
the blonde's ruler

The “pole-vaulter” paradox

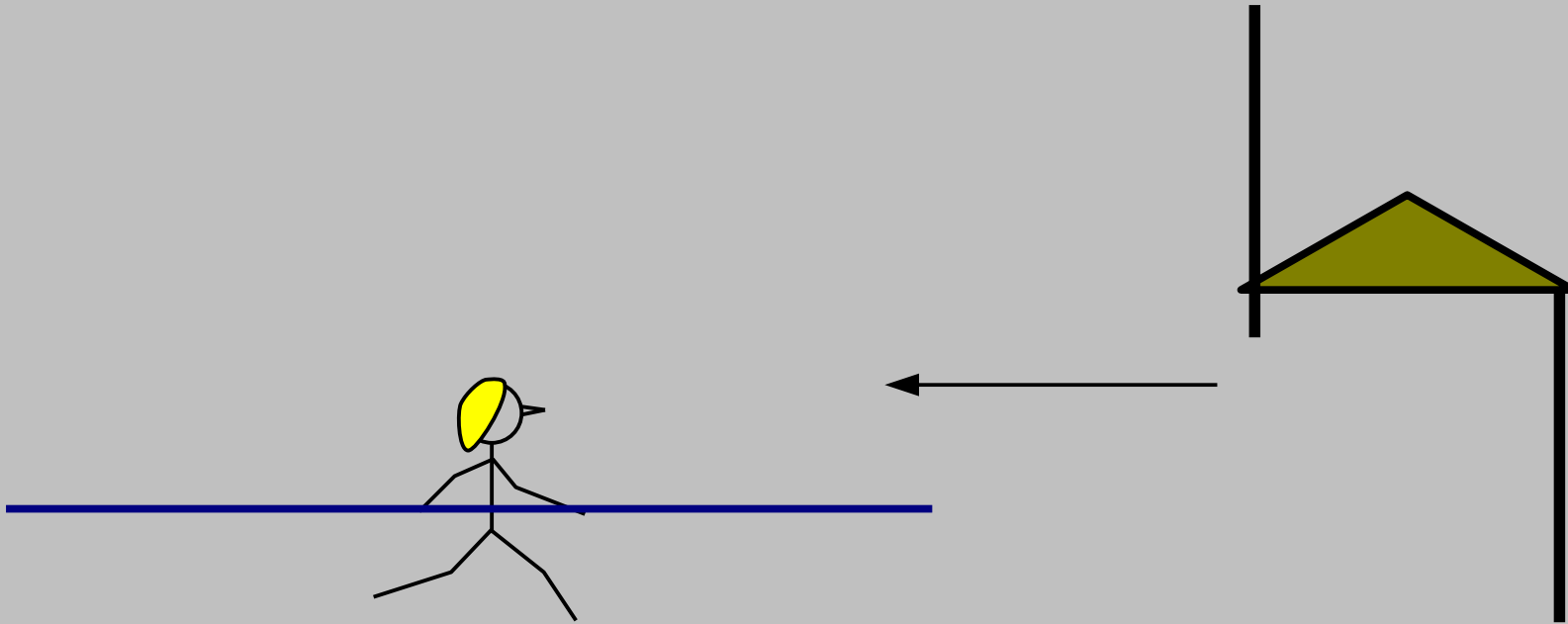


Procedure : Pole vaulter runs at the shed at very high velocity.

The instant that the front of the pole reaches the right-side door, the right-side door opens and the left-side door closes.



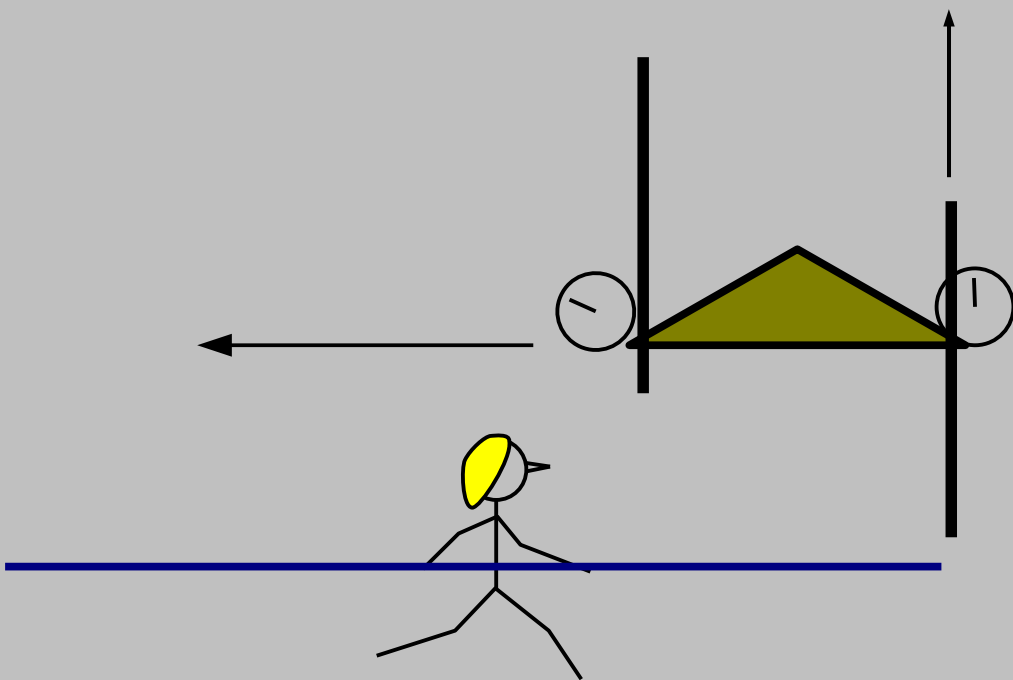
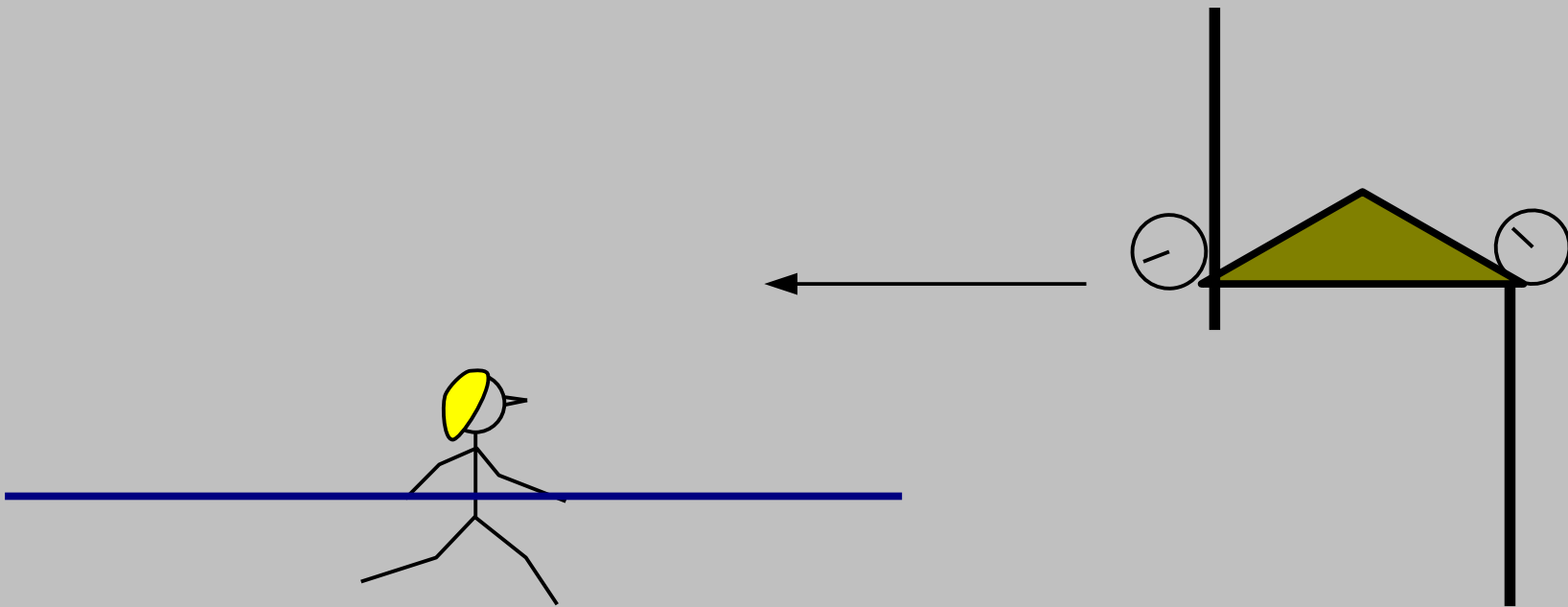
...but, in the pole-vaulter's frame...

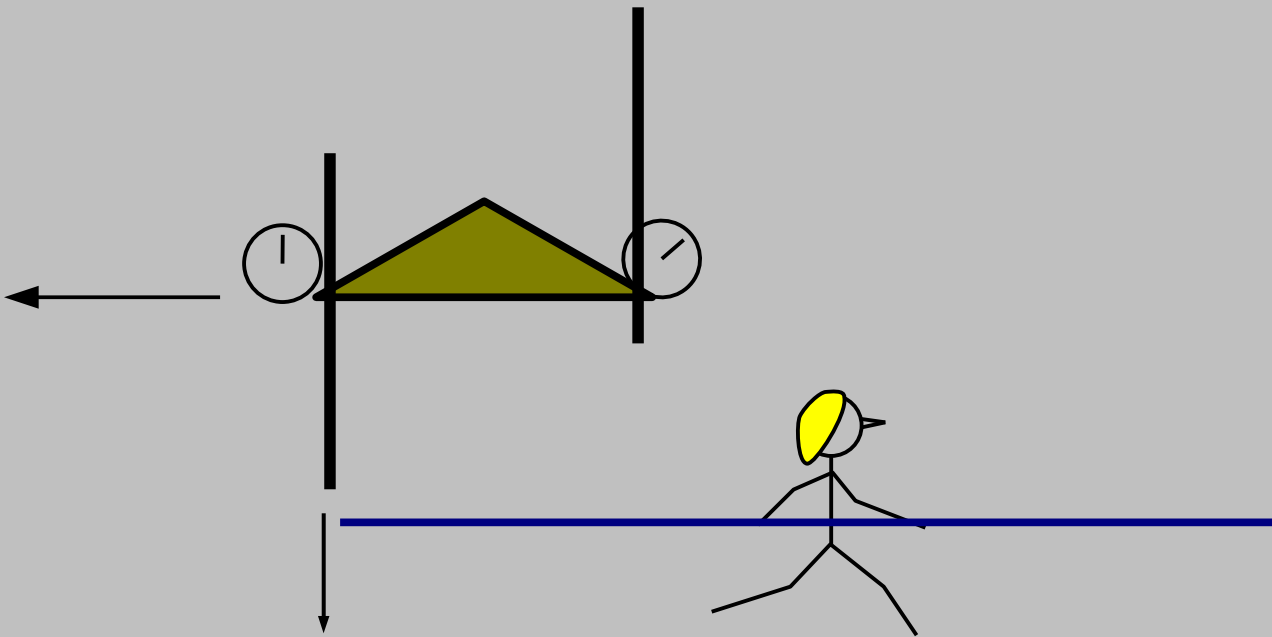
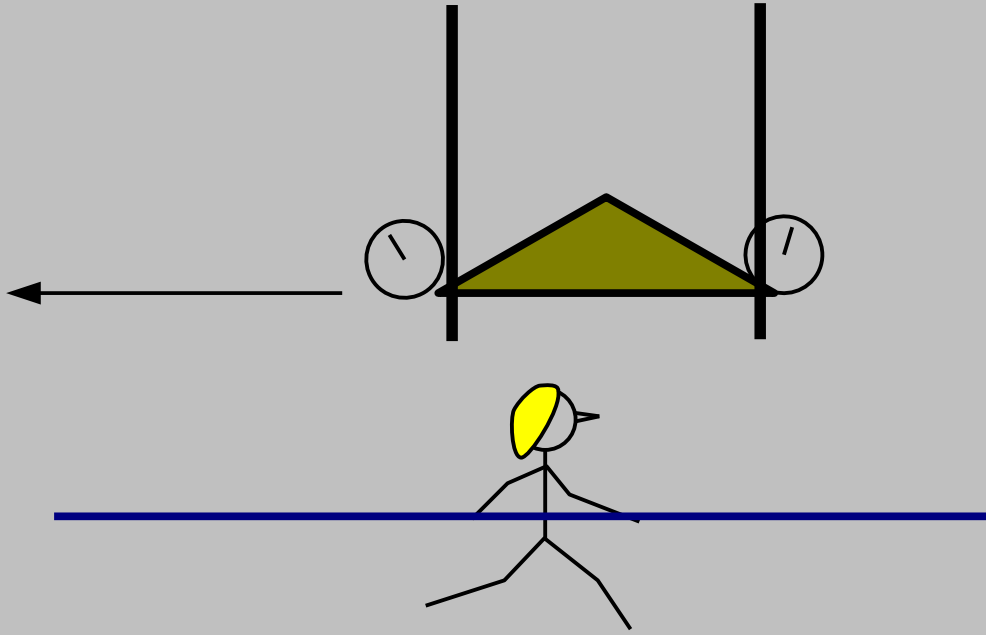


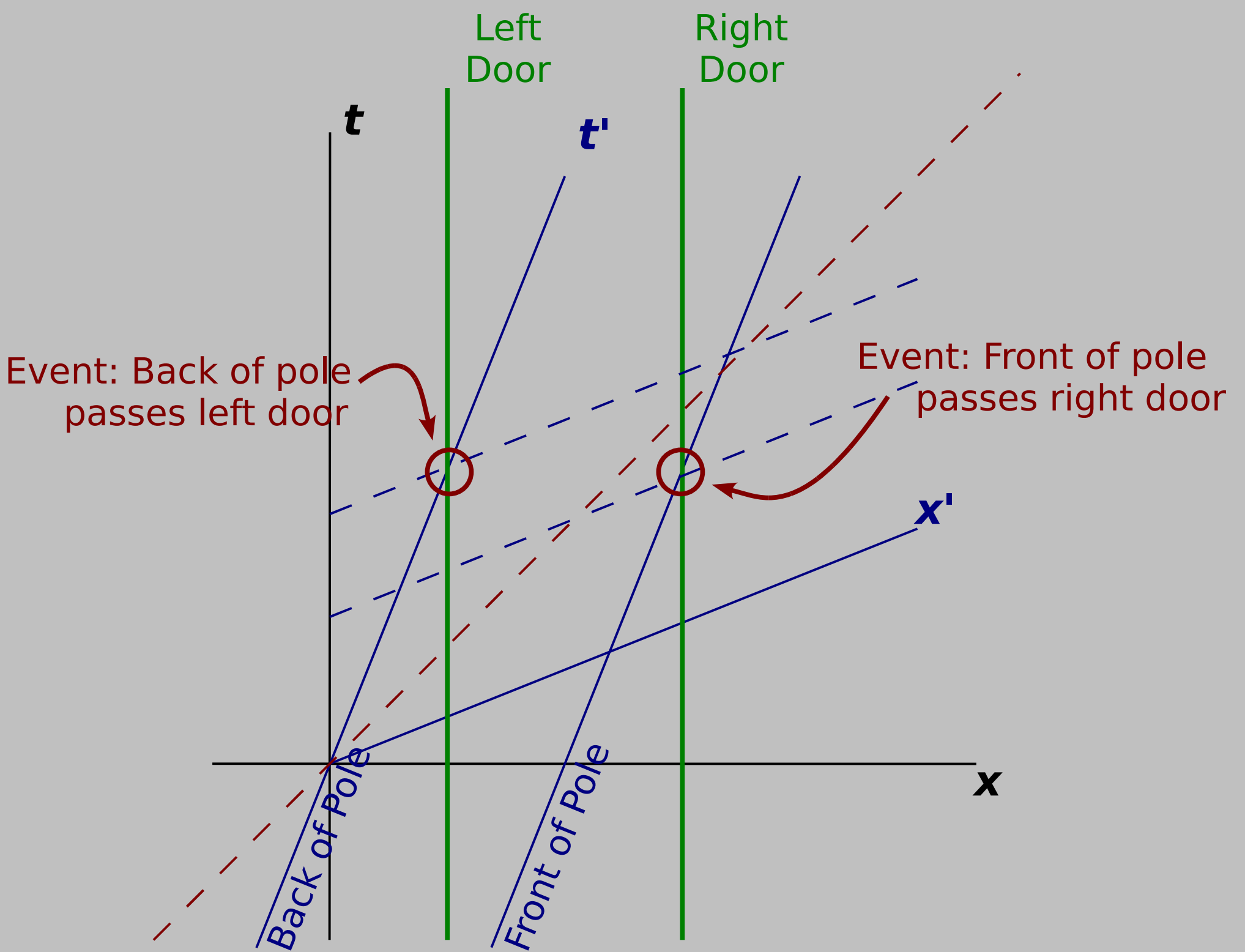
...so, does the pole fit or not? Is there a collision or not?

Resolution: Simultaneity

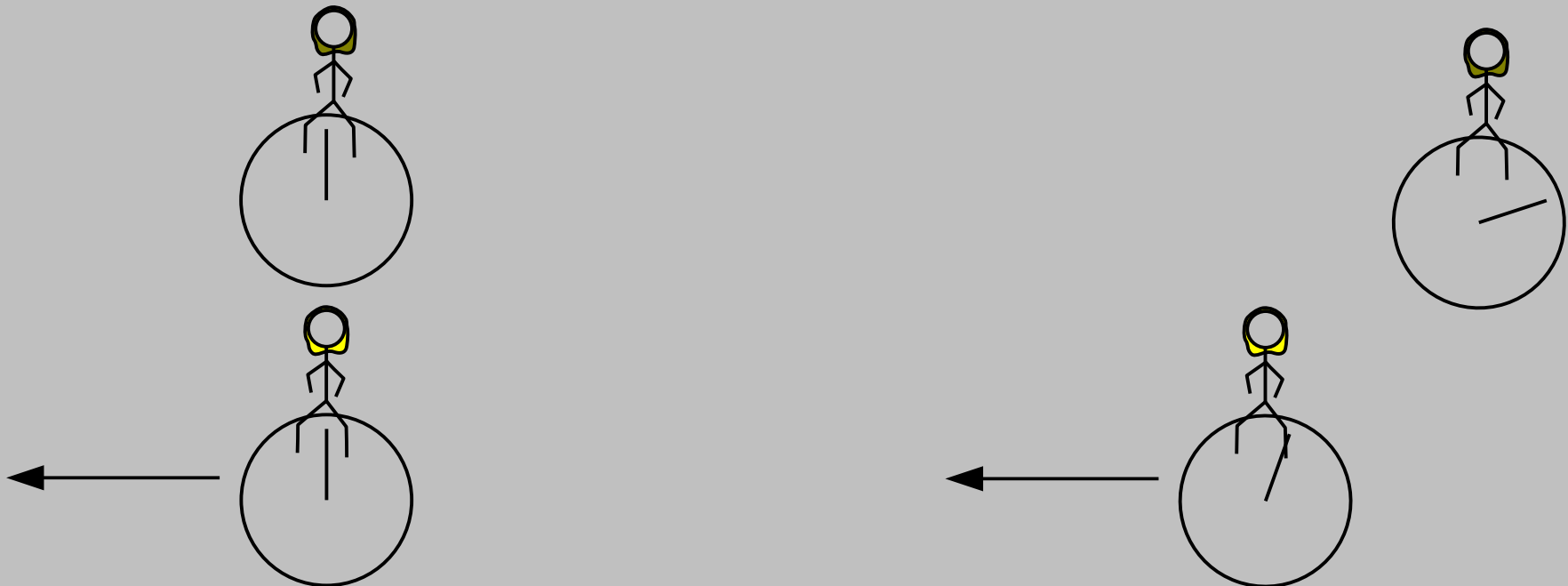
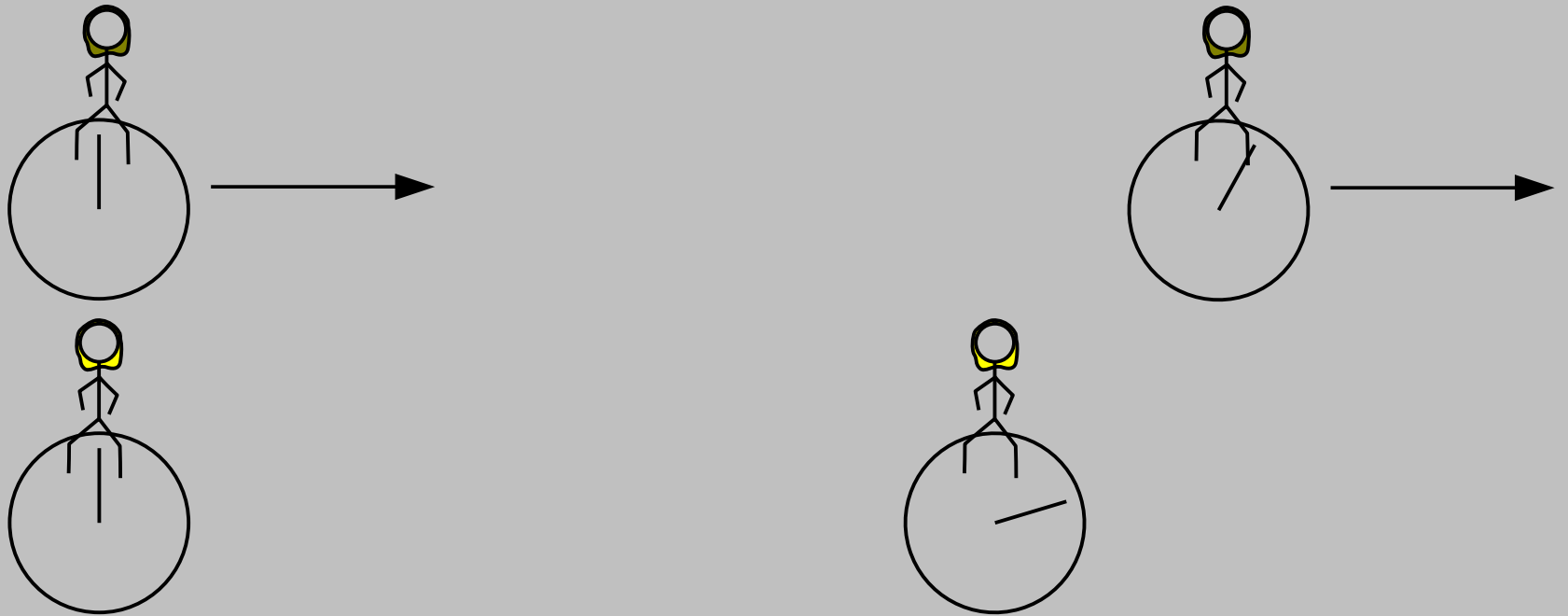
Two events are only at the same time in all frames of reference if they're also at the same point in space.



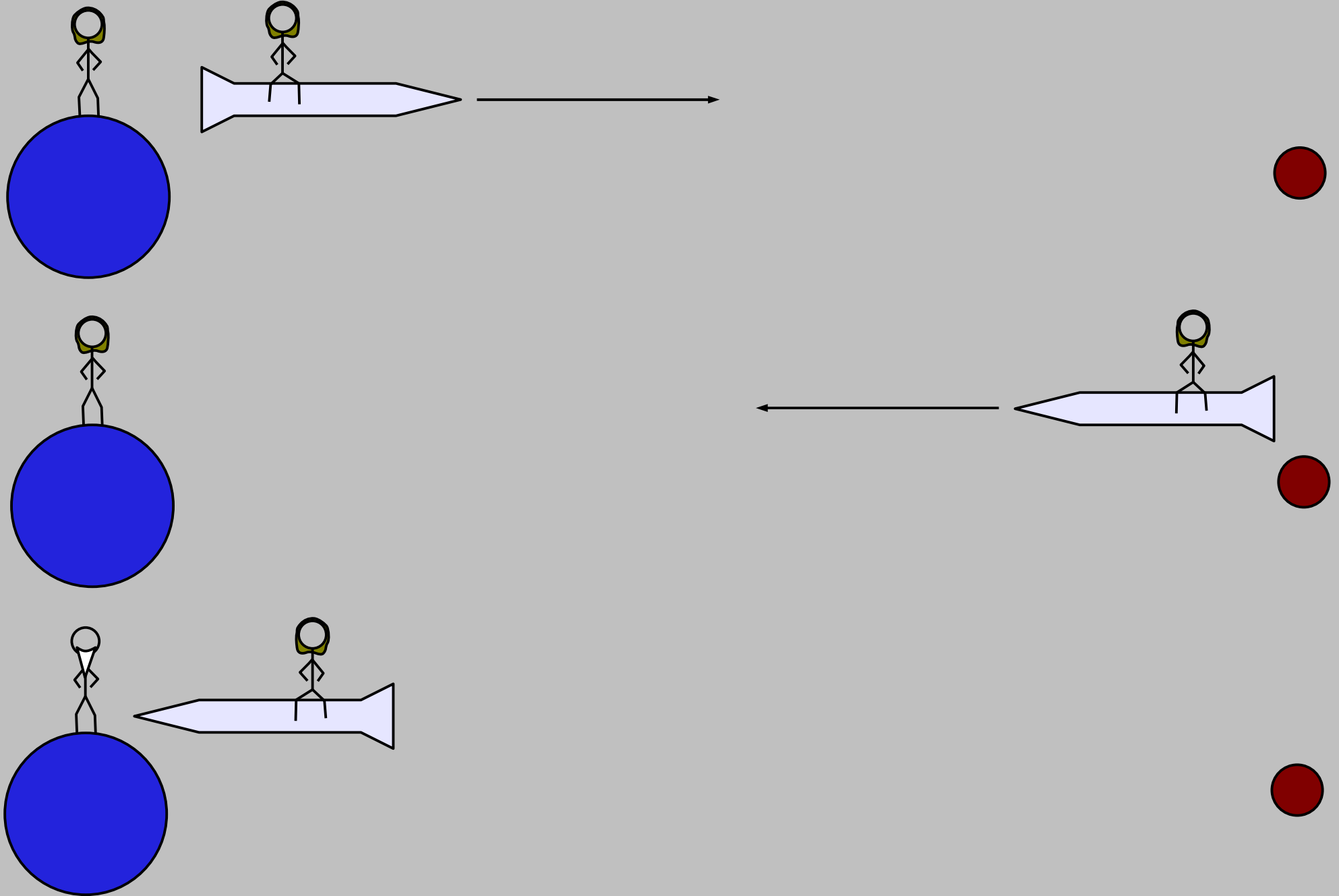




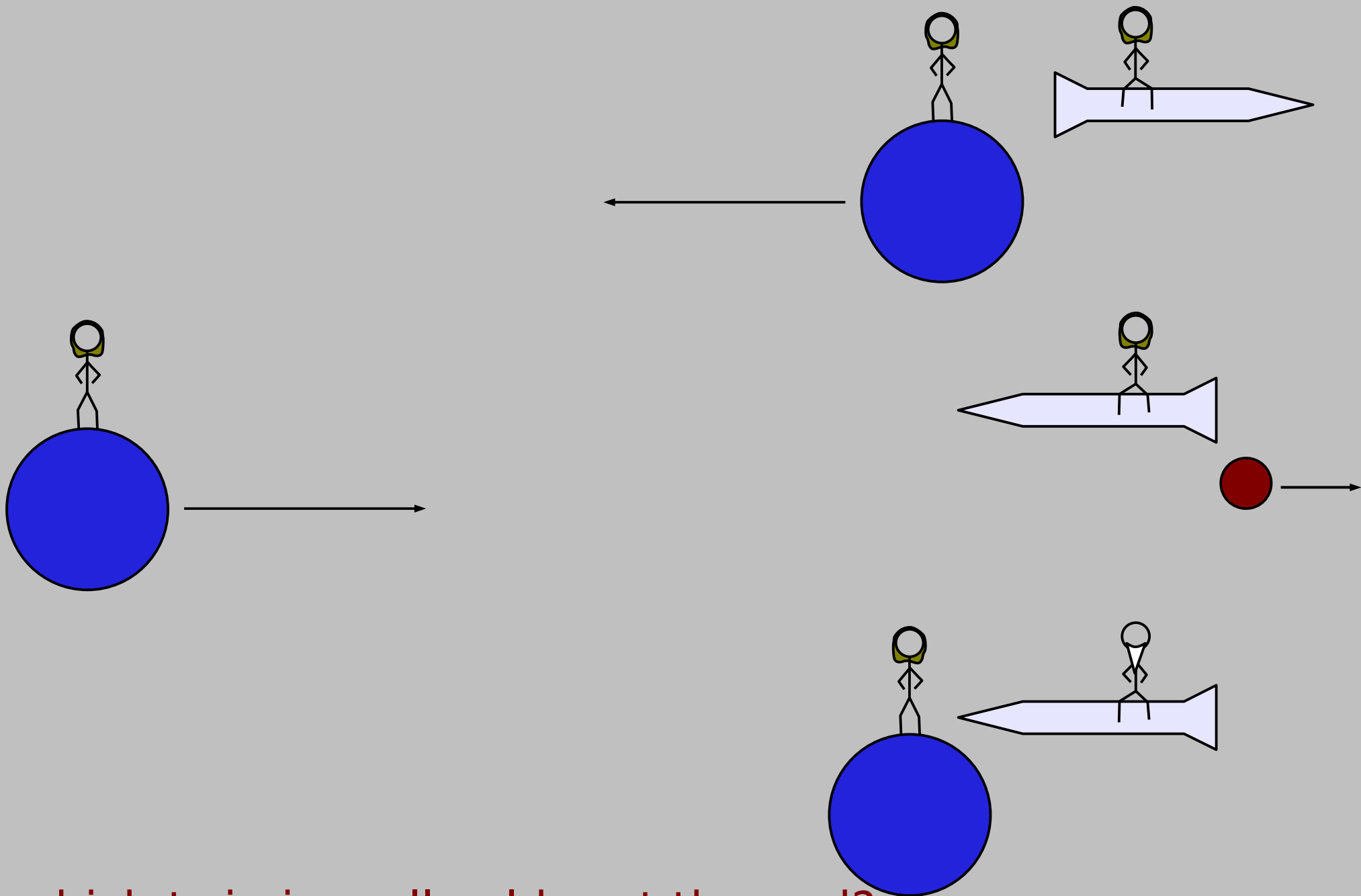
Full relativity also applies to time dilation...



The twin paradox

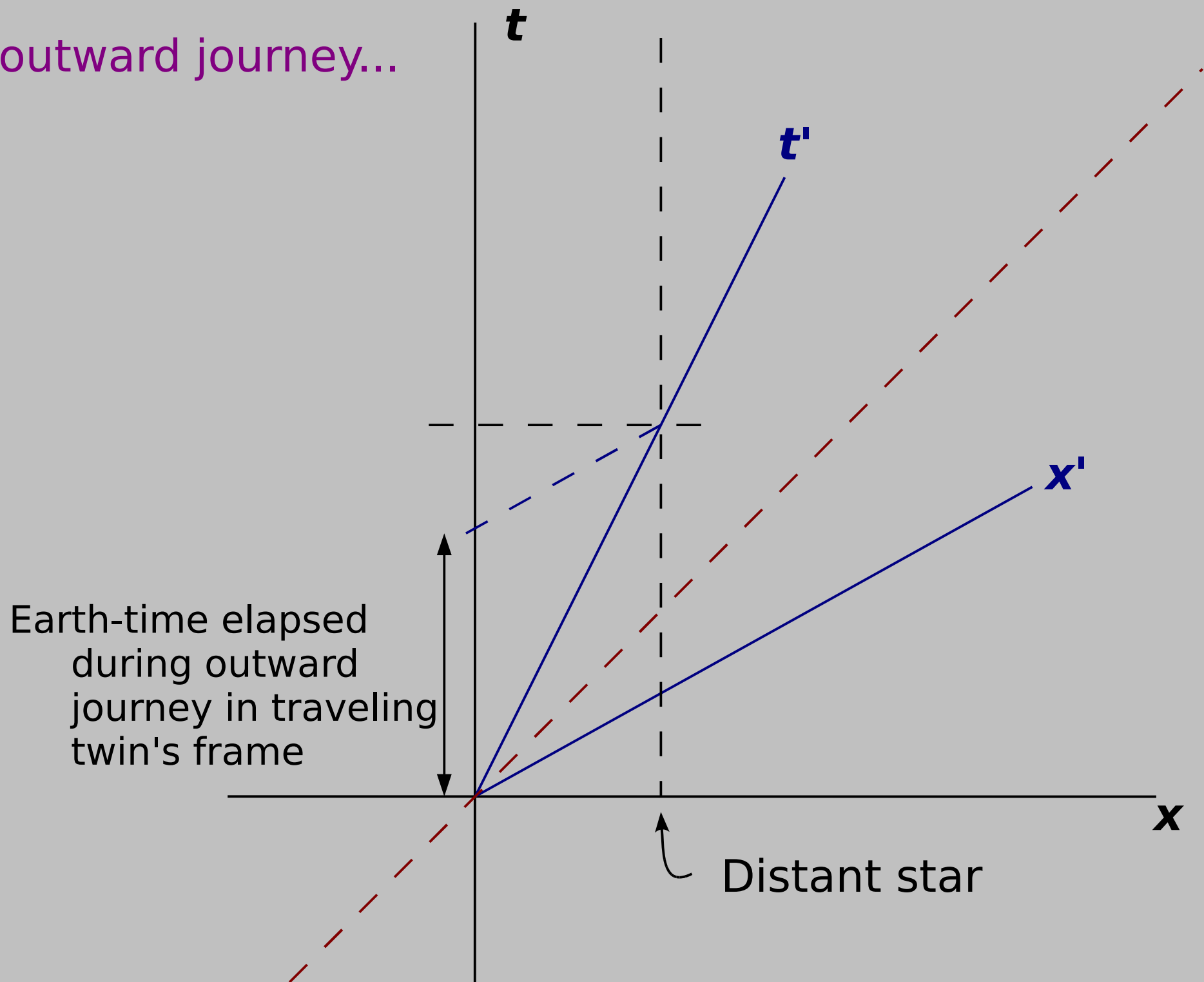


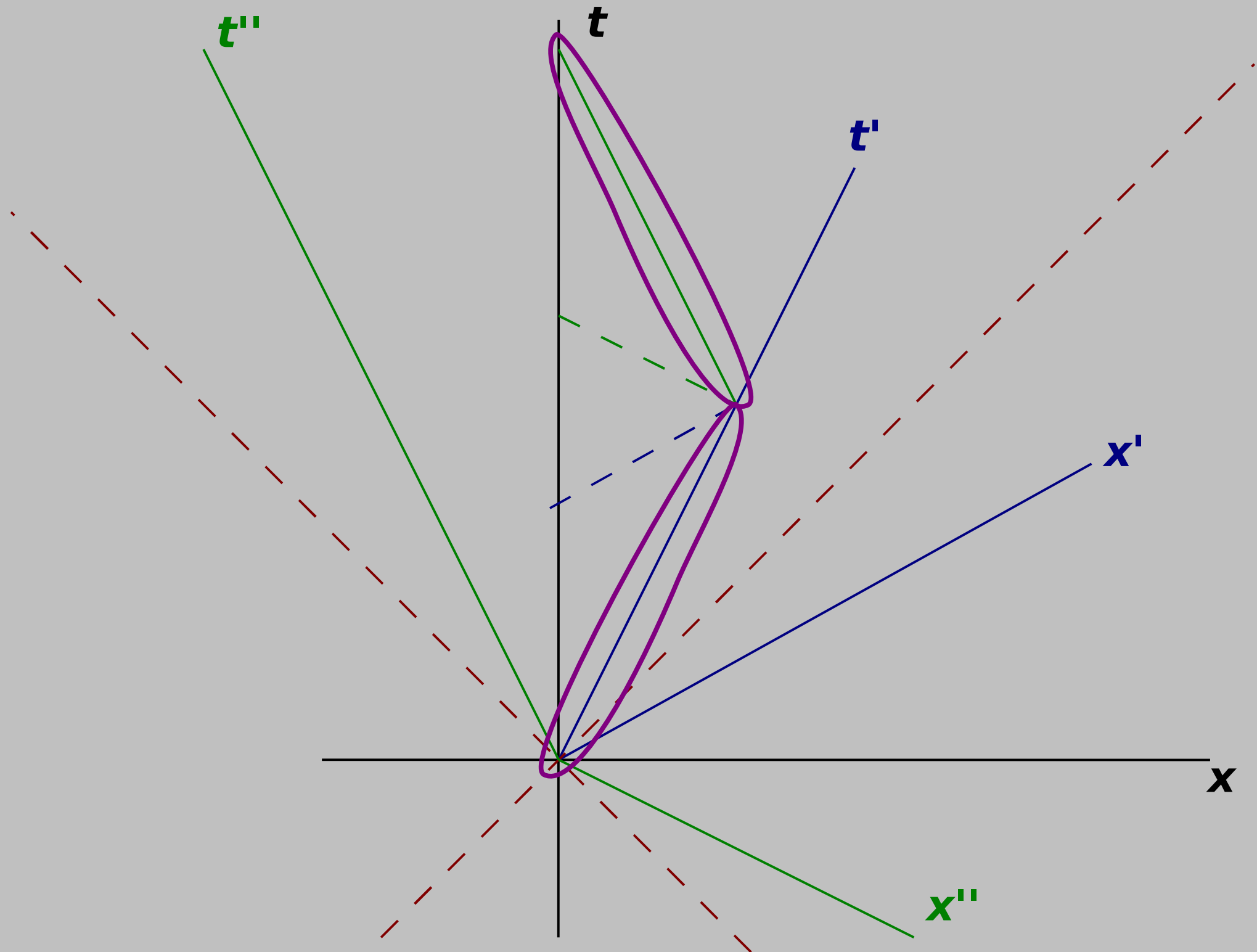
From the rocket twin's point of view...



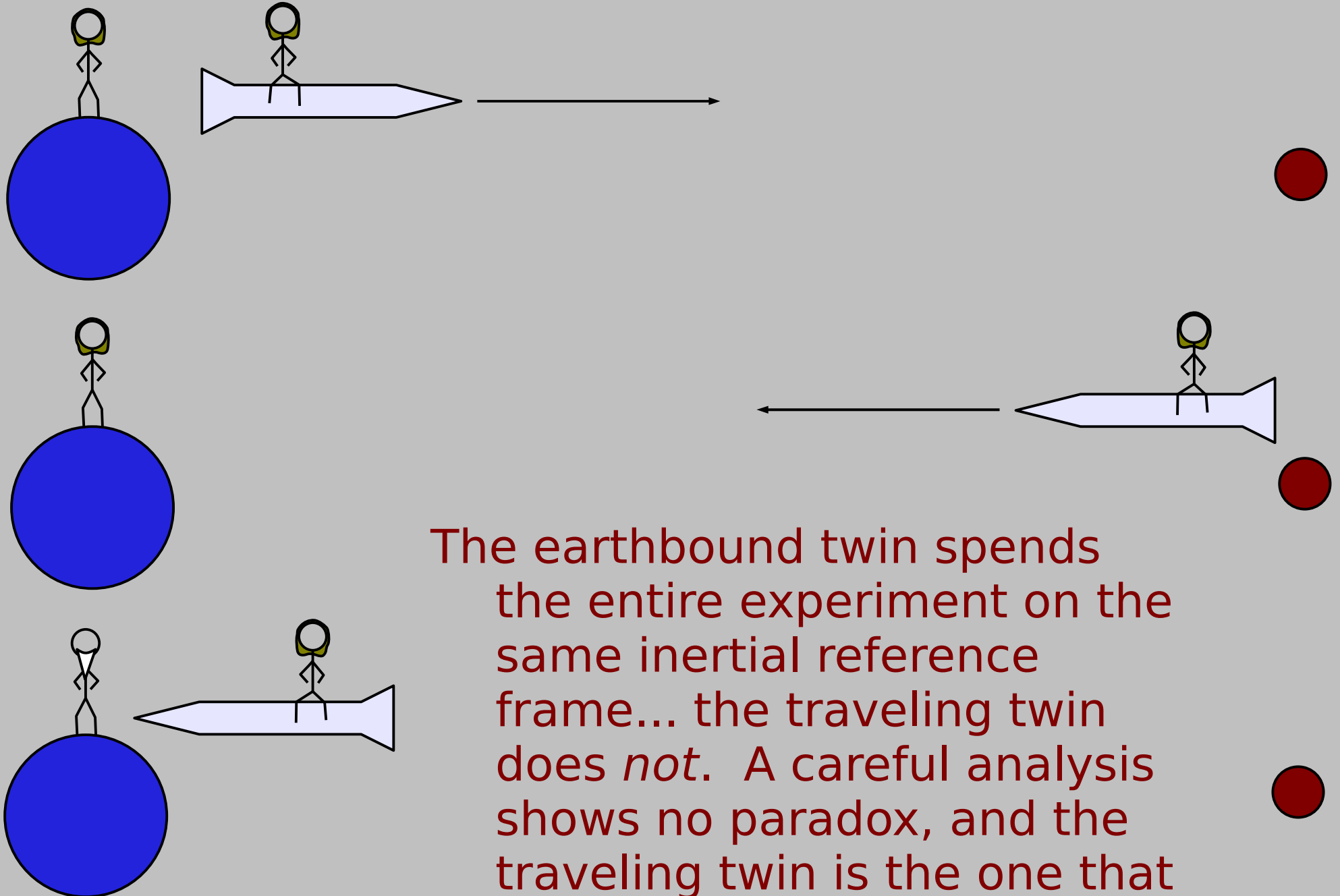
...which twin is really older at the end?

The outward journey...





The twin "paradox"



The earthbound twin spends the entire experiment on the same inertial reference frame... the traveling twin does *not*. A careful analysis shows no paradox, and the traveling twin is the one that ages *less*.

Summery

(It is very nice outside!)

- The postulates of Special Relativity (SR) lead to the conclusion that time isn't absolute, but two folks' ideas about space and time differ based on their relative speeds
- Length contraction, time dilation, simultaneity
- The “paradoxes” of SR aren't really paradoxes, but result from our natural intuitive instinct that time is absolute
- The resolution to many “paradoxes” is just to remember to take simultaneity into account!
- If an observer moves from one frame of reference to another, much care is required to do the analysis right.