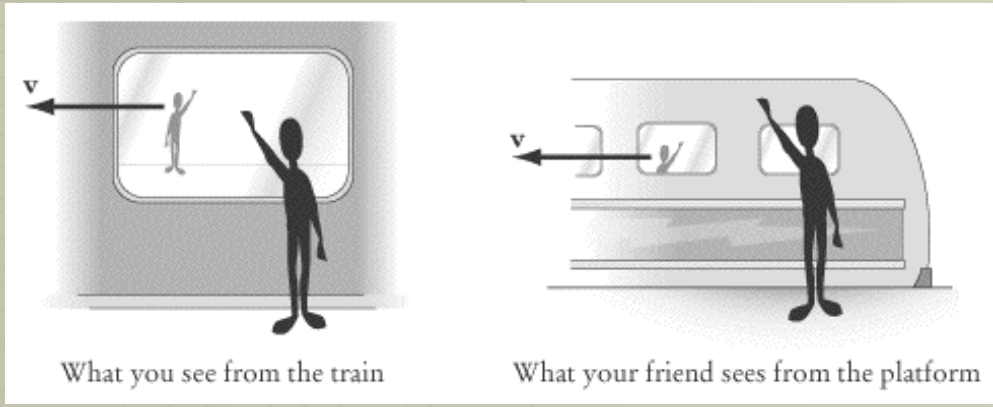
This is page 17. It is Honors Only. It is Special Relativity – the stuff that made Einstein famous. It’s okay if you’re confused at the end – it’s why Einstein is Einstein.

# Special Relativity

- The **laws of physics** are **the same** in all **inertial reference frames.**
  - Inertial reference frame means the reference frames are **moving at constant velocity relative to one another.**



# Special Relativity

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This is postulate #1 – physics is true everywhere that's inertial frame. If it accelerates, then bets are off

# Special Relativity

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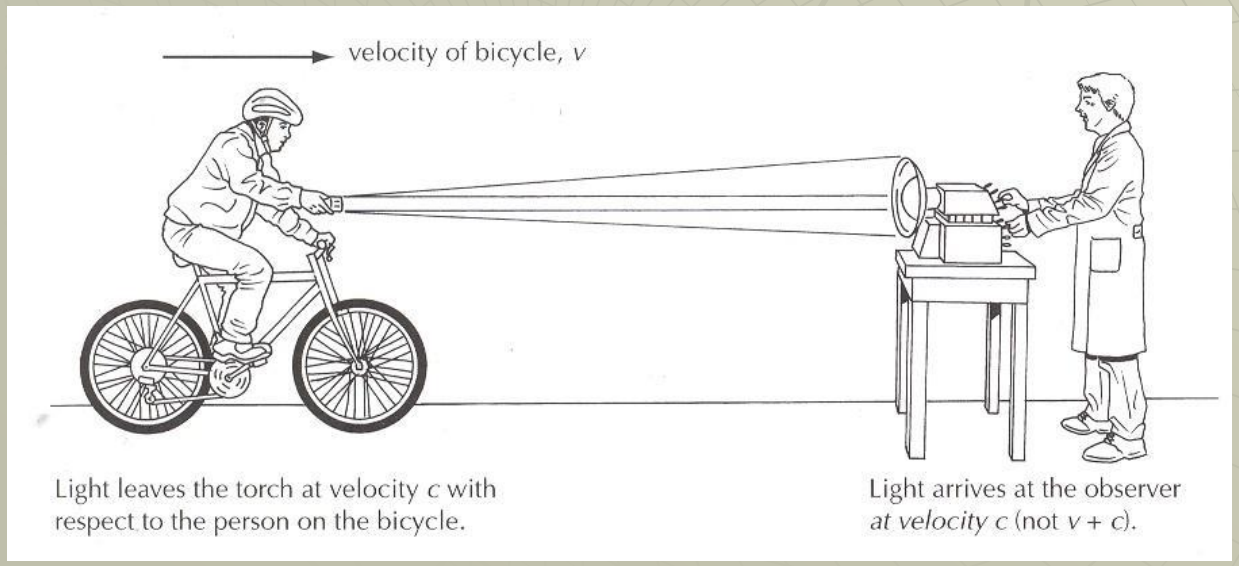
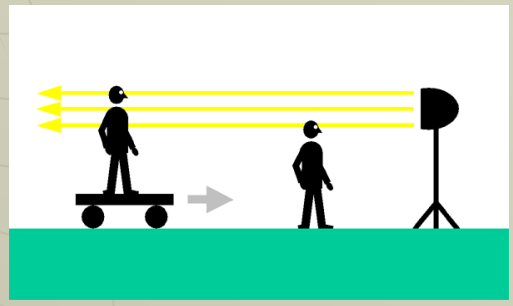
Moving at constant speed – picture you on a train and someone on the platform – those are inertial frames of reference.

# Special Relativity

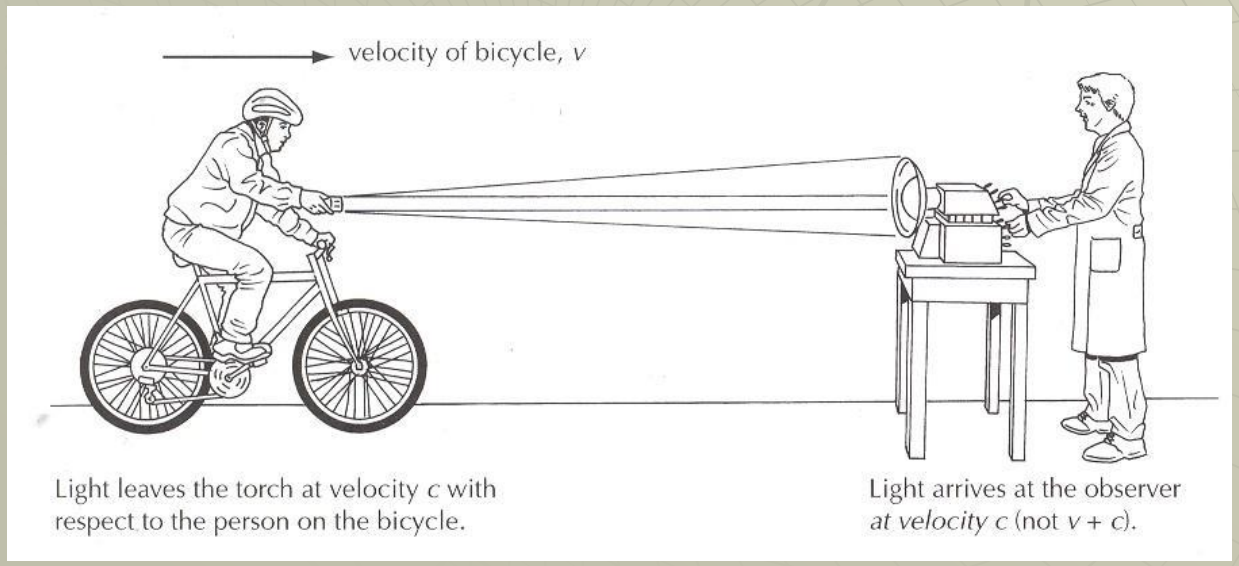
- The **speed of light** is **constant** in all reference frames, despite any **relative motion** between **an observer** and the **light source**.

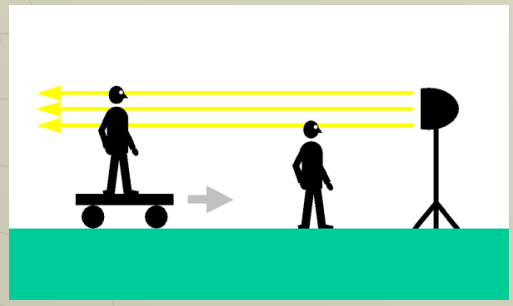


# Special Relativity

It seems simple – the speed of light is constant – but it's where things get weird – if we have two people running at each other, normally we add their speeds. But not with light – it's still $3x10^8$ m/s. So distance and time have to change.



# Can You Go the Speed of Light?

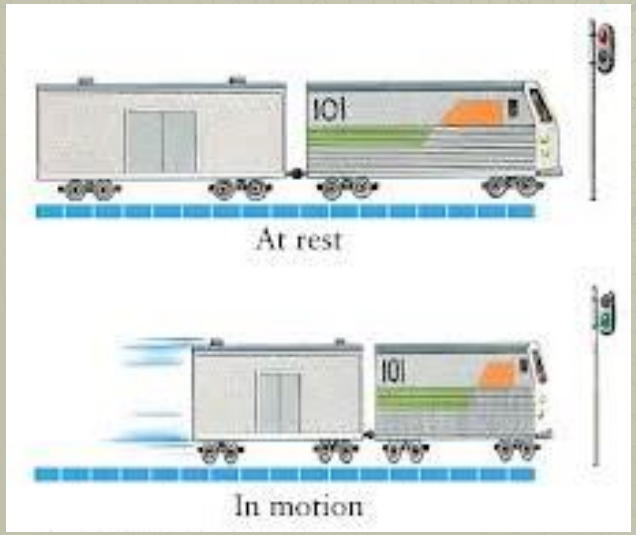
https://www.youtube.com/watch?v=vVKFBaaL4uM&t=4s

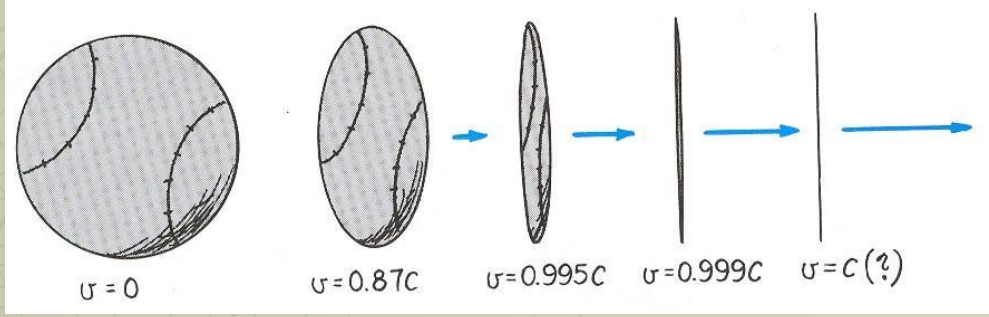
(can go c)

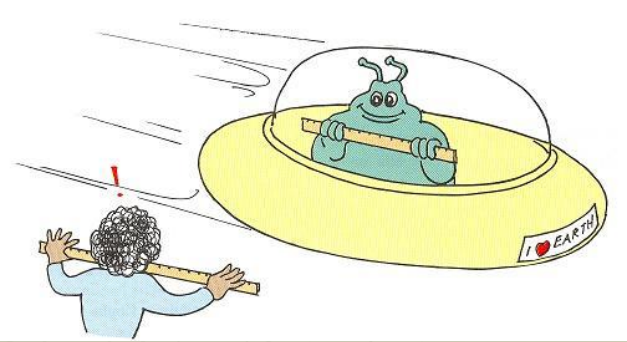
# Simultaneity


(simultaneity)

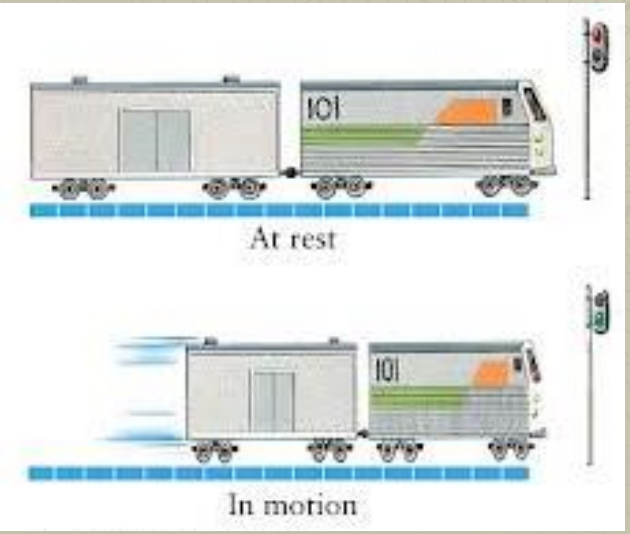
- Length Contraction – the **length** of an object **contracts in the direction of motion** when measured by **a stationary observer**.
  - The **faster** the object travels, the **shorter** it becomes.

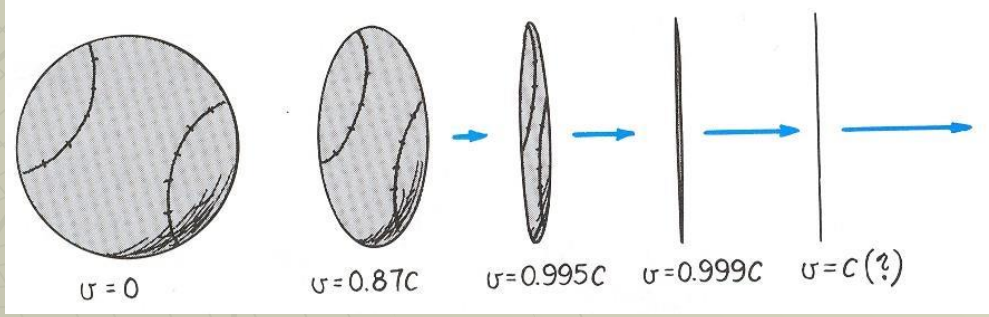


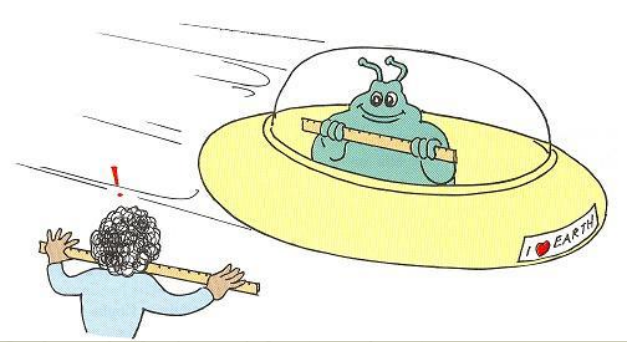



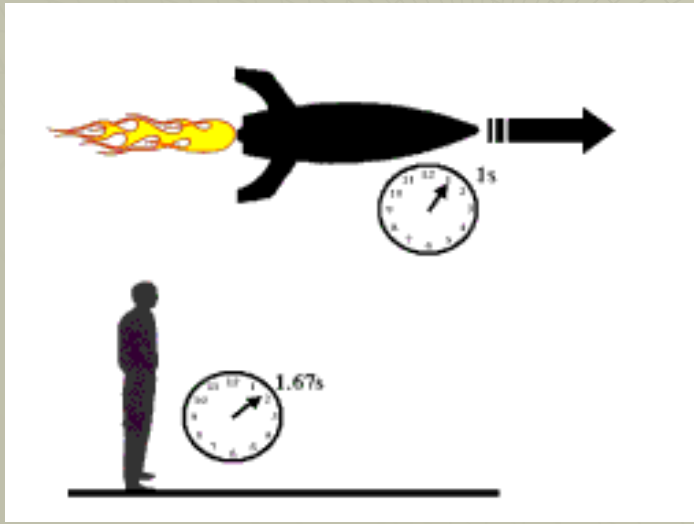
This is one thing you NEED to know. And it only gets shorter in the direction you're moving, not side to side. So you would get closer to your laptop but not squish in shoulder to shoulder.

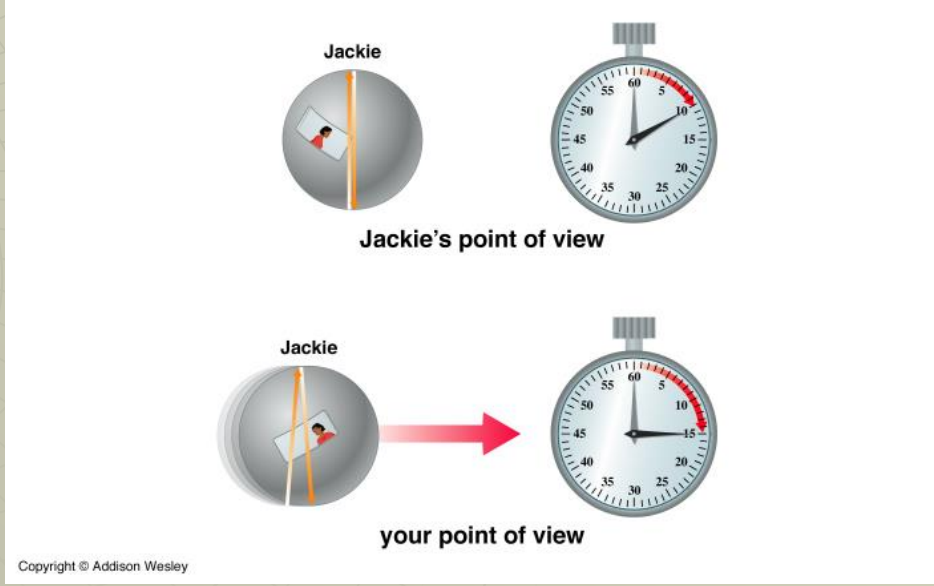


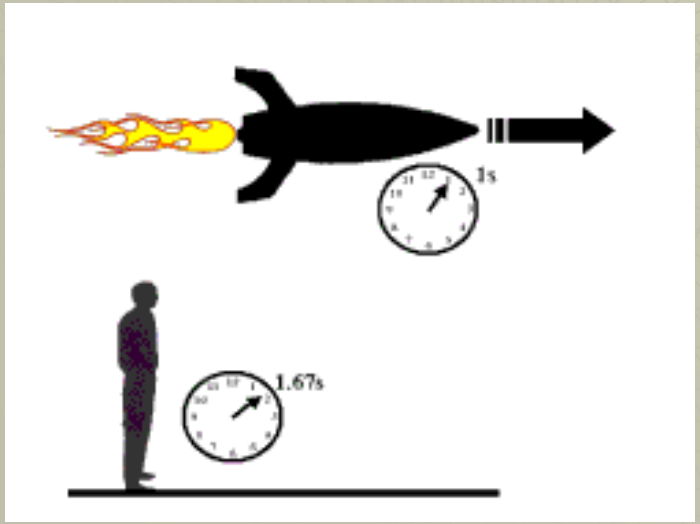



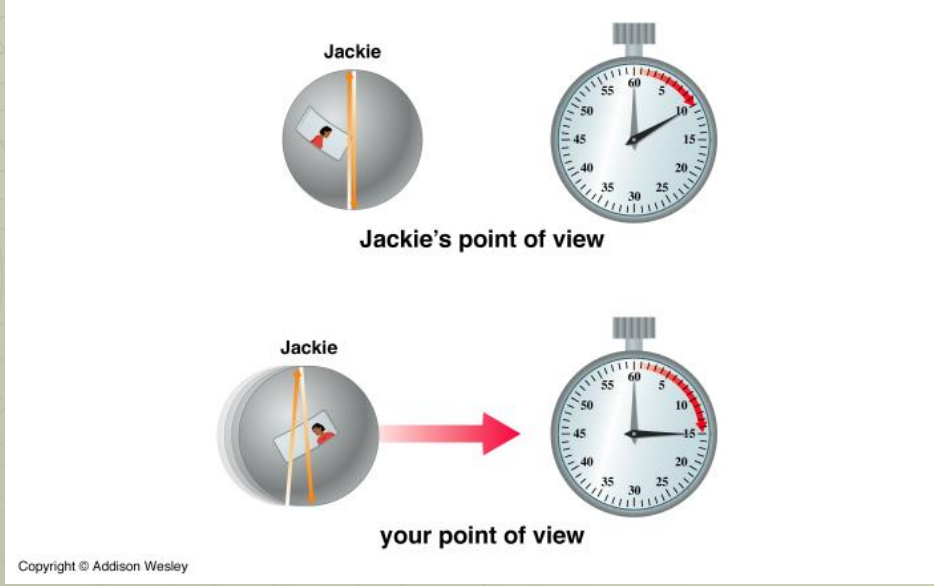
- Time Dilation – time slows down at high speeds
  - **<u>Moving</u>** clocks run more **<u>slowly</u>** than **<u>stationary</u>** clocks. The **<u>faster</u>** the clock moves, the **<u>slower the time runs</u>**.
  - Each **<u>observer</u>** believes **<u>their time</u>** is the **<u>normal time</u>**



This is something you NEED to know – moving clocks run slower. So if you're closer to the speed of light, time slows down – a minute for you is a year for the outside world (for example). You'd be able to time travel into the future but not come back to the present.

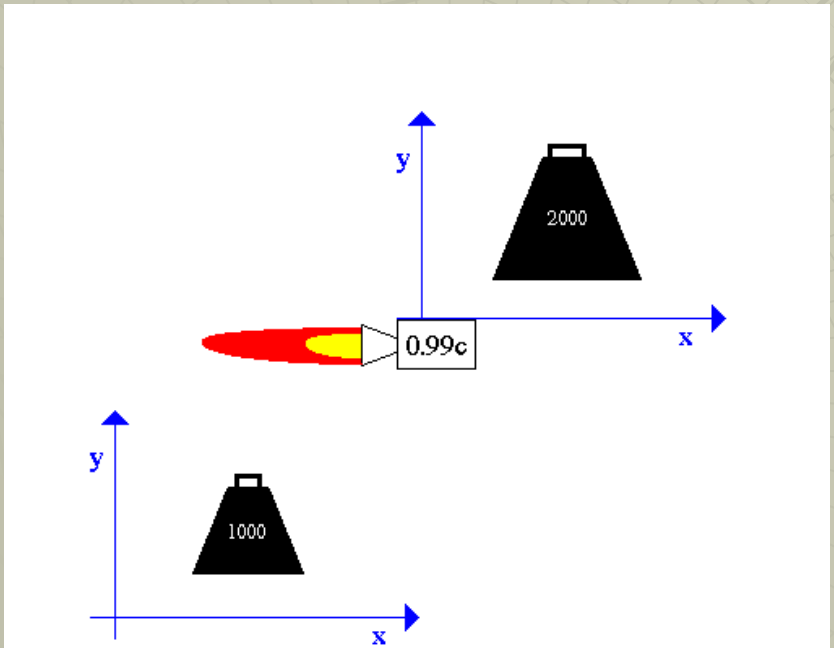


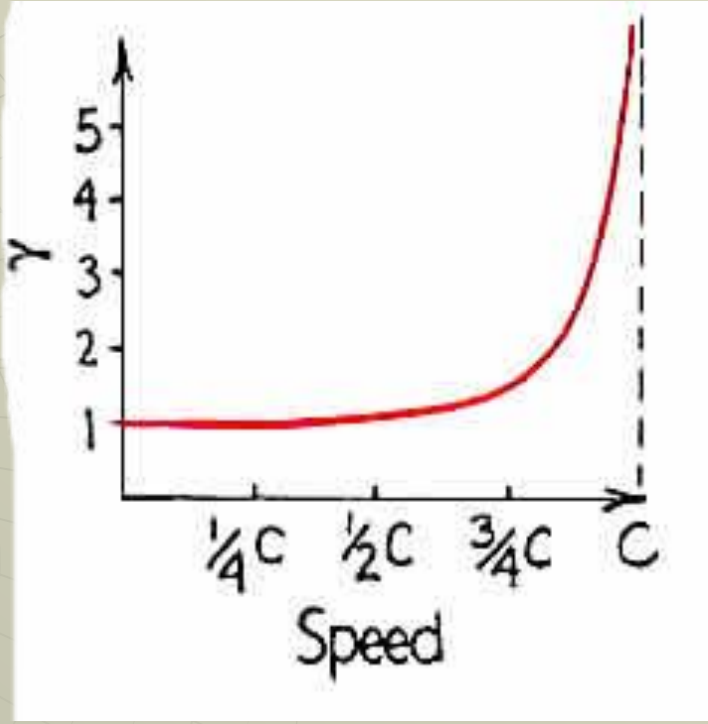
# Time Dilation


(time dilation)

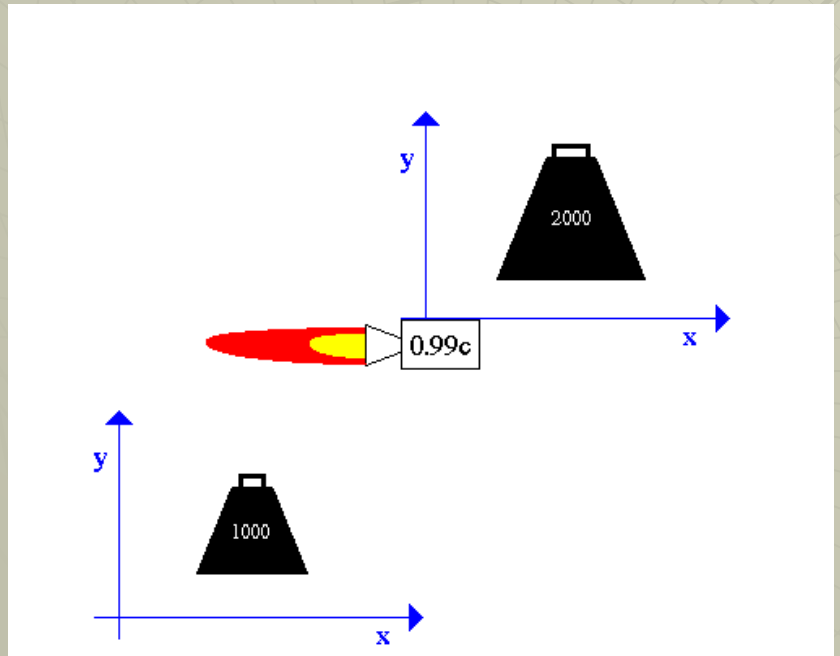
- Relativistic Mass – as the **velocity** of an object **approaches the speed of light**, the **mass increases** toward **infinity**



an objects mass increases as it approaches the speed of light



This is the third thing you NEED to know. As you approach the speed of light, your mass increases, but you can never reach c, so there's an asymptote at c.



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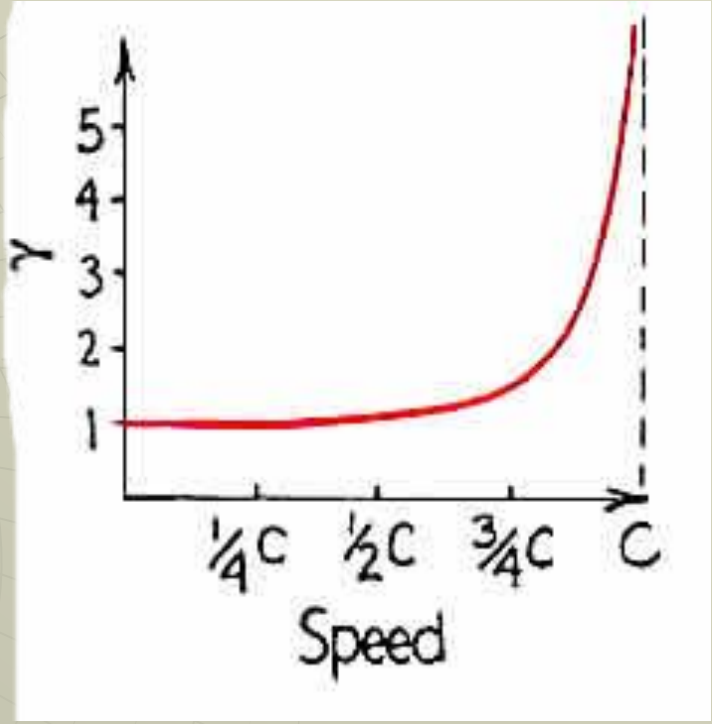
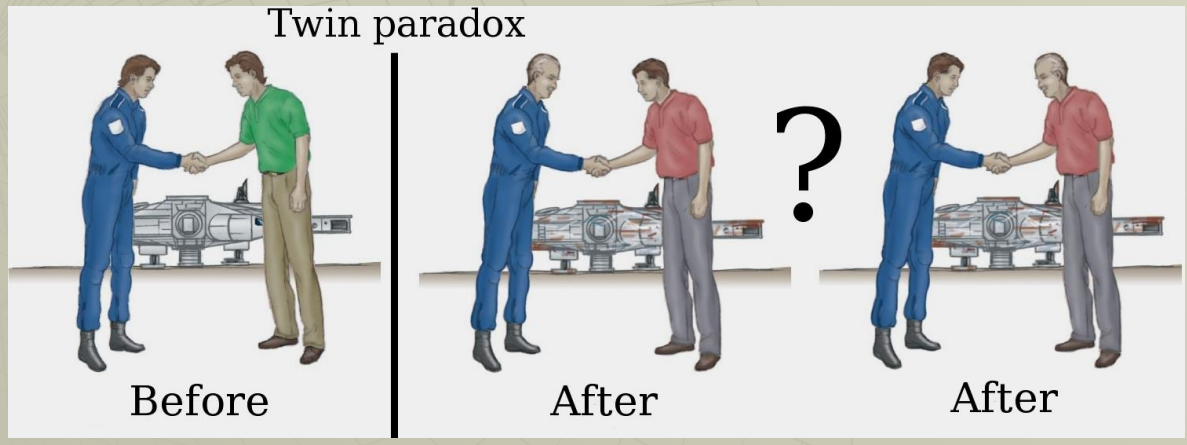
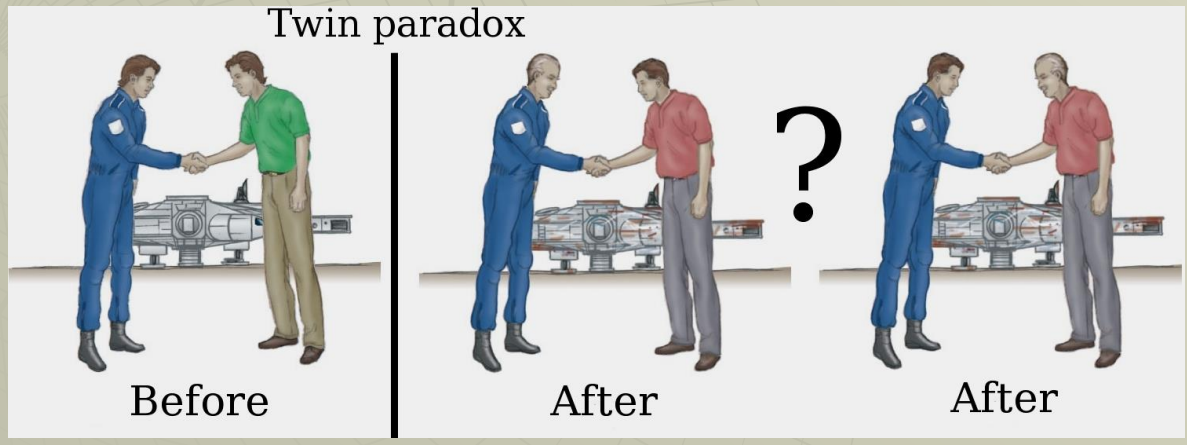


- Twin Paradox - The astronaut twin goes on a journey to a distant star in a very fast rocket ship. The scientist twin stays home. When the astronaut twin returns home, who is older?
  - According to the scientist, he is at rest while the astronaut was moving, so the astronaut ages more slowly and is younger.
  - According the astronaut, he is at rest while the scientist was moving, so the scientist ages more slowly and is younger.

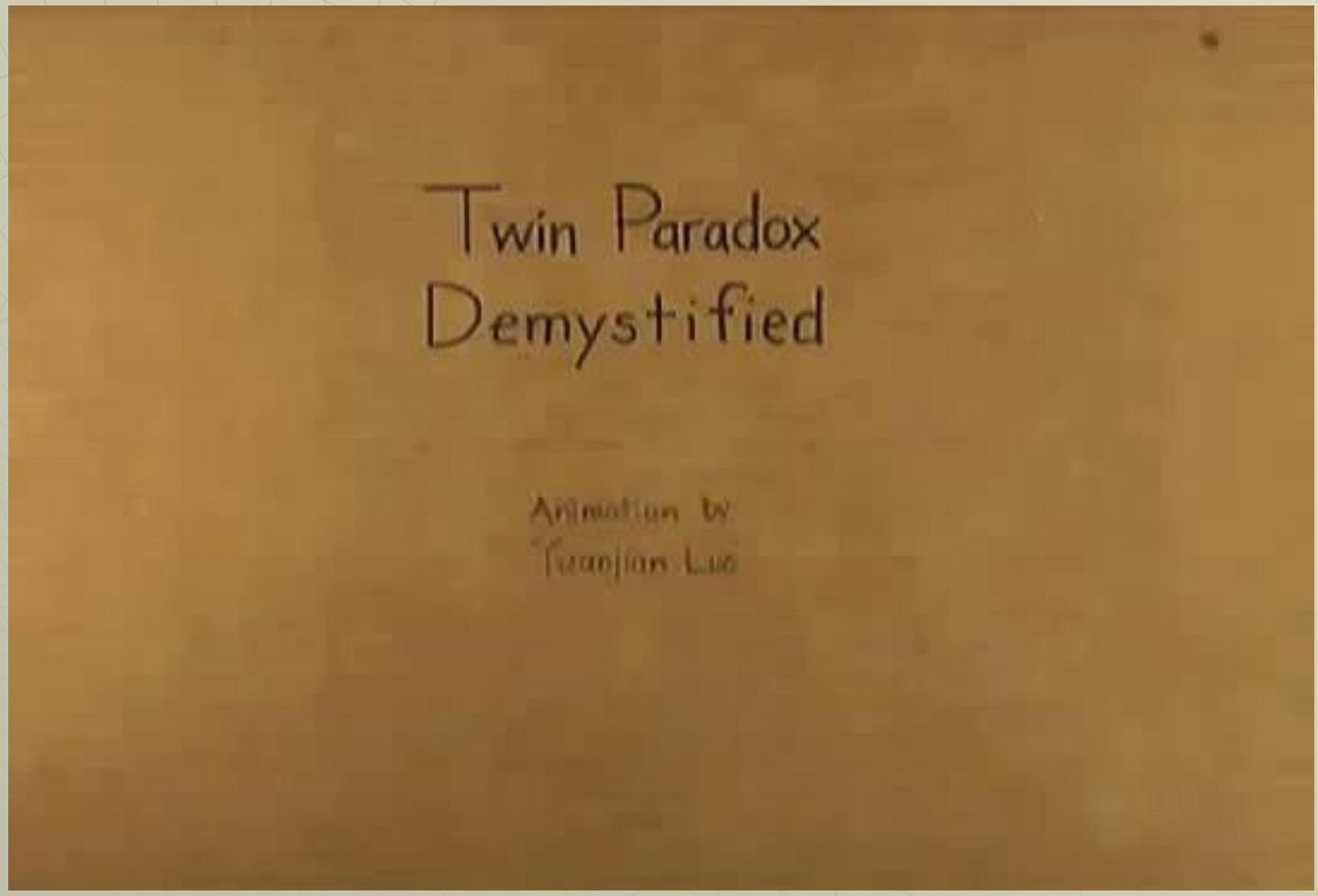


- Twin Paradox - The astronaut twin goes on a journey to a distant star in a very fast rocket ship. The scientist twin stays home. When the astronaut twin returns home, who is older?

If you've seen Interstellar you already know the answer.



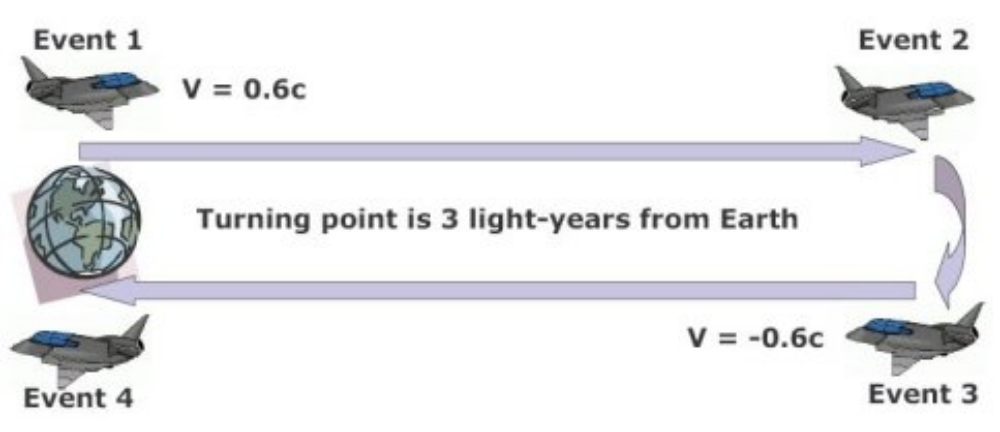
# Twin Paradox

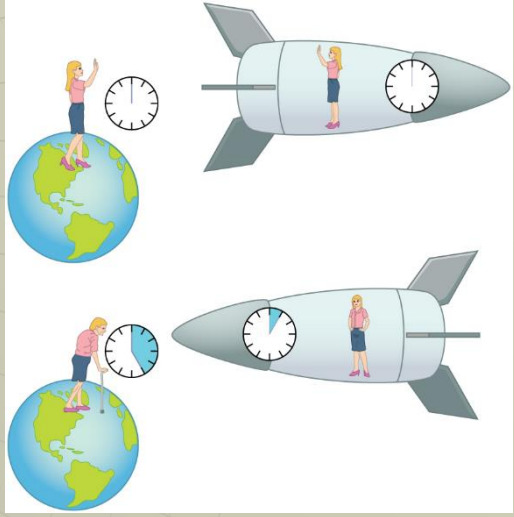



(twin paradox)

- Twin Paradox - The astronaut twin goes on a journey to a distant star in a very fast rocket ship. The scientist twin stays home. When the astronaut twin returns home, who is older?
  - Resolution:

The astronaut's frame of reference is non-inertial (it accelerates), so he really is the one moving at high speeds and his time will run slower. The astronaut is younger.



- Resolution:

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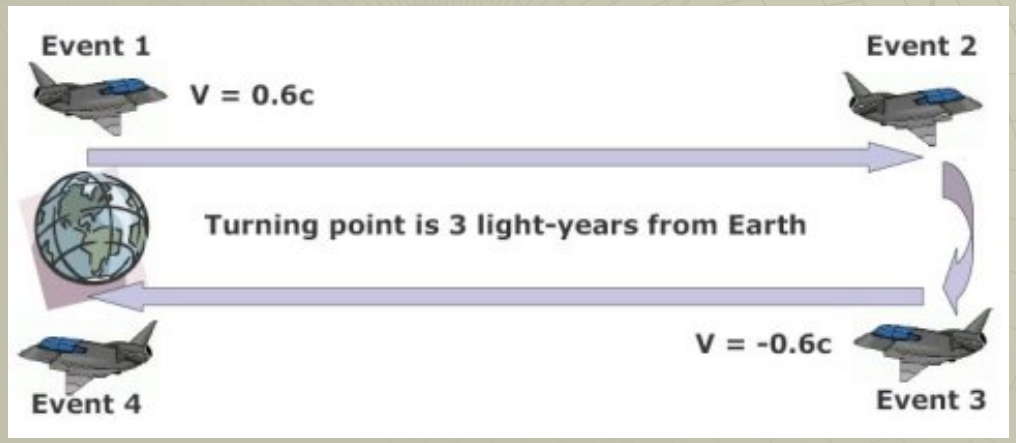
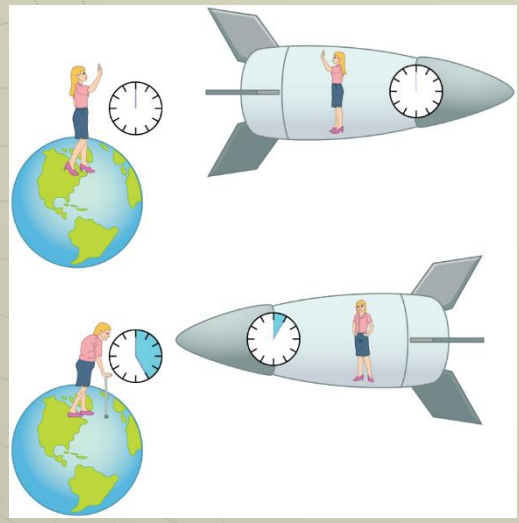
You don't need to know the Twin Paradox, it's just a cool brain melting idea.



# The End.

(or for some of you….
To Be Continued….)