

Time Travel

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Outline

- 1 Einstein's Relativity
- 2 Time Travel To The Past

Time Delay

- Imagine that you are traveling in a spaceship. According to the theory of special relativity, an observer at rest outside of the spaceship will see that the clock in the spaceship runs slower than that of the observer. The time delay effect is given by

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- A sort of time travel to the future is possible as a consequence of the time delay effect.

Proxima b

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- Imagine that we are sending a manned spaceship to Proxima b, which can travel at 90% of the speed of light. For people on Earth, it would take

$$(\Delta t)' = \frac{4 \times 10^{13} \text{km}}{2.7 \times 10^5 \text{km/sec}} = 1.481 \times 10^8 \text{sec} \approx 4.7 \text{yrs}$$

for the spaceship to get to Proxima b. Since it would take the same from Proxima b to Earth, the overall travel time is 9.4 yrs to people on Earth.

Proxima b

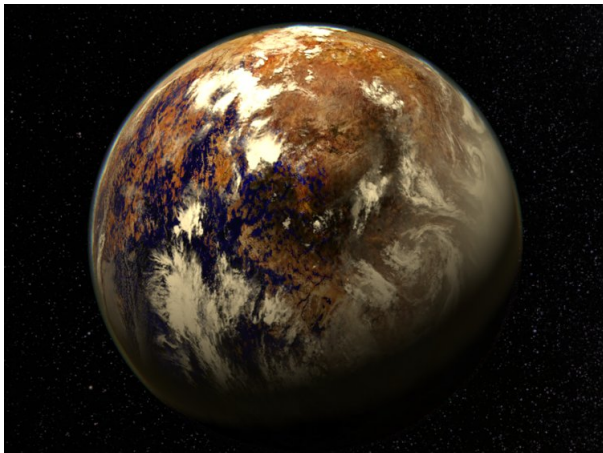


Figure: Artist's depiction of Proxima b

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- So when they come back home it's like they traveled for more than 5 years forward in time.

But This Is A Boring Time Travel!

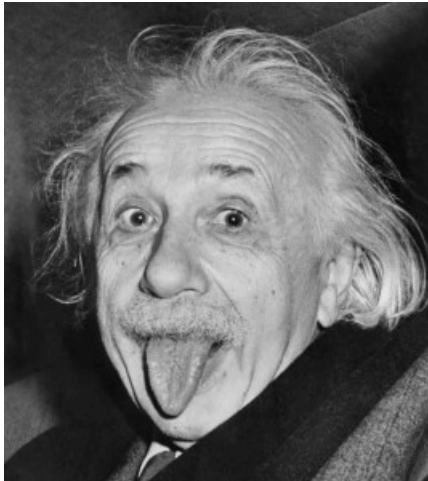


Figure: Teasing Einstein

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- Even if the future might have already happened, for us in current time it didn't happen yet. So due to causality violation, traveling forward in time is in fact impossible.
- Can we travel backward in time? This is one of the most intriguing questions not only in physics but also in sci-fi like one travels back in time and alter the future. Is that really possible?

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- Grandfather paradox happens because of the assumption that time is one-dimensional.
- What if time can be multi-dimensional? No more grandfather paradox!
- How time can be multi-dimensional? Is there a physical reason for that?
- Yes, *Chronology Protection Conjecture* (CPC)!

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- *The Boring Physics Conjecture*: There are no wormholes and/or spacewarps. There are no time machines/timewarps.

Protect History At All Cost!

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- as soon as any tempering with recorded history occurs, a new timeline has to be created in order to prevent history from being rewritten, i.e. a new reality is created separately from the previously existing reality.
- This new reality may turn out to be pretty similar to the previous reality or it may turn out to be completely different.

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- When a massive star dies, it collapses due to the influence of its own gravity. This phenomenon is called *gravitaional collapse*.
- If the star is very massive, the gravitational collapse leads to a *black hole*.

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- A black hole is connected to a white hole, its counterpart, through a tubelike region called a *Lorentzian wormhole*.

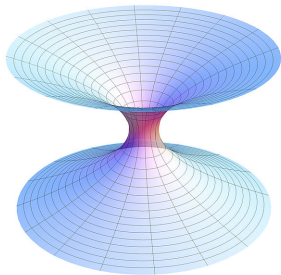


Figure: Wormhole

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- Due to timewarp, the exit of the wormhole (white hole) will open up at an event in the past.

Some Wild Thoughts

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- The so-called alien visitors (if they exist) may not actually be aliens but are time travelers from the future (in a different reality).