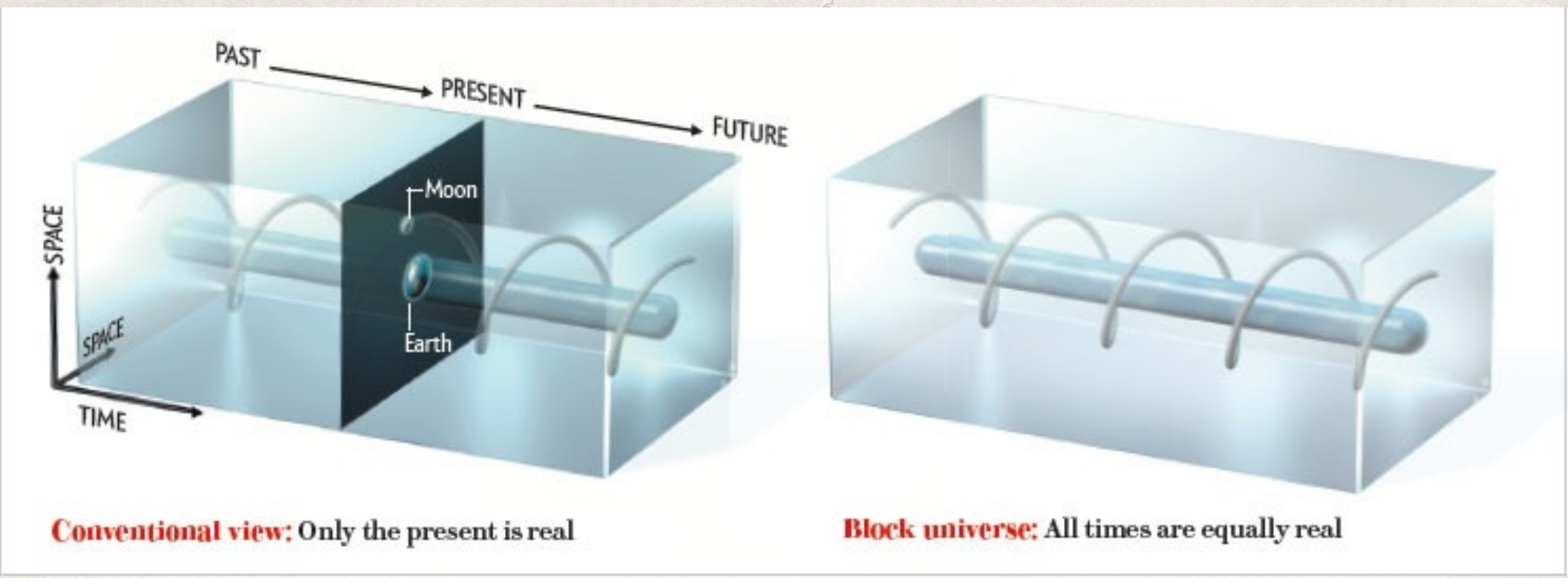


Marcello Di Bello

Lehman College
CUNY

Time as block

PHI 171 - Fall 2014

Last Week: Aspects of our **Experience of Time**

- **The flow of time.** *Why does time seem to flow?*
- **Duration**. *How do we measure time periods as longer or shorter?*

Last Week:
Augustine's Puzzle About the **Flow of Time**

- The past does not exist: it does not exist anymore
- The future does not exist: it does not exist yet
- The present does not exist: it tends to non-existence

How can we experience the flow of time if past, present and future do not exist?

Last Week: Augustine's Puzzle About **Measuring Time**

- The past does not exist: it does not exist anymore
- The future does not exist: it does exist yet
- The present has no space, no extension

How can we measure time if past and future do not exist and the present has no extension? Of what do we measure that it is longer or shorter?

Last Week: Augustine's Solution

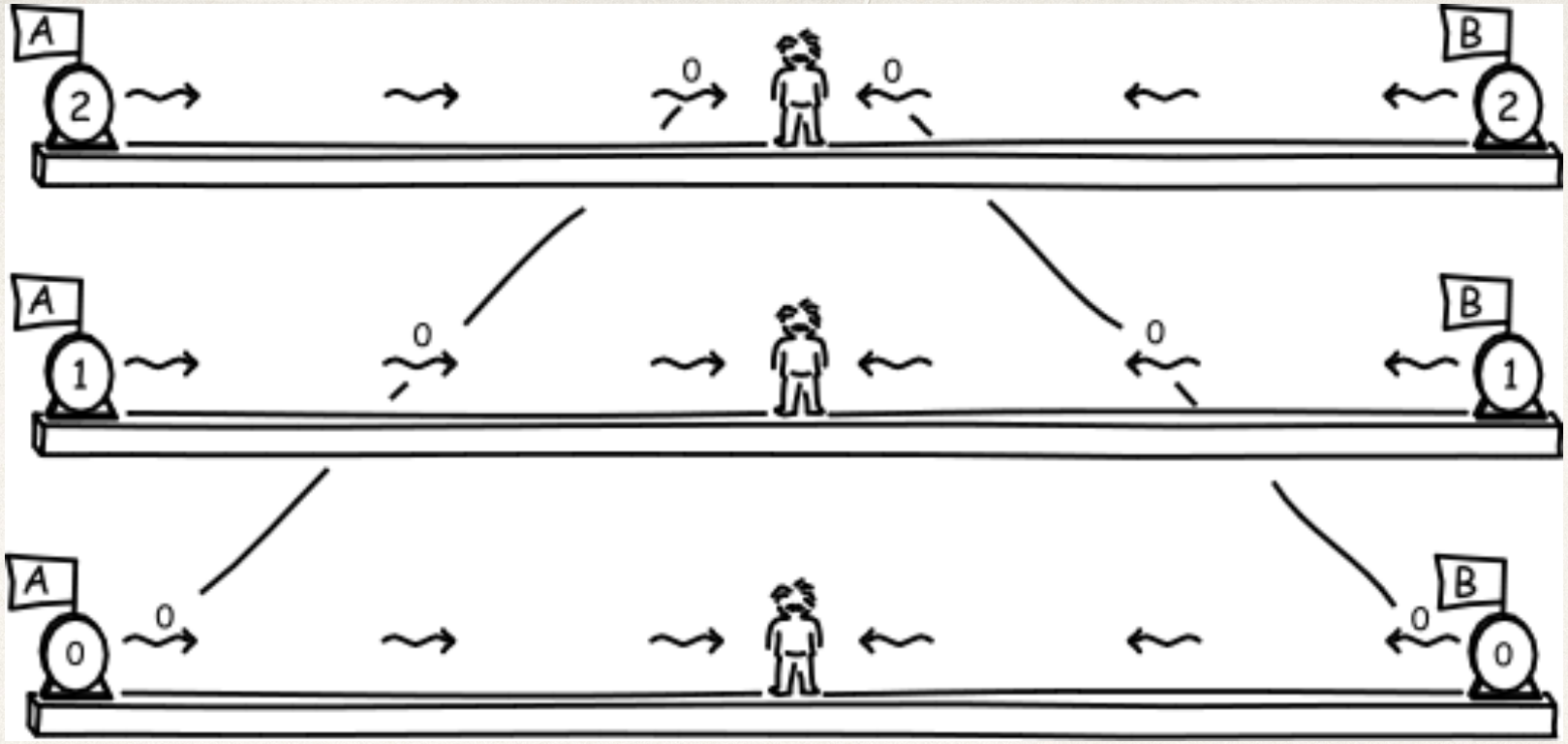
Times only exists in the mind.

The flow of time is nothing other than the mind stretching itself backward and forward.

Future is the expectation of an event. We measure the *expectation* of an event, which can be long or short.

Past is the memory of an event. We measure the *memory* of an event, which also can be long or short.

Let's Now Turn from the **Experience** of Time to the **Physics** of Time



Event **P1** = *pingpong ball leaves A when clock reports time 0 and moves left-to-right*

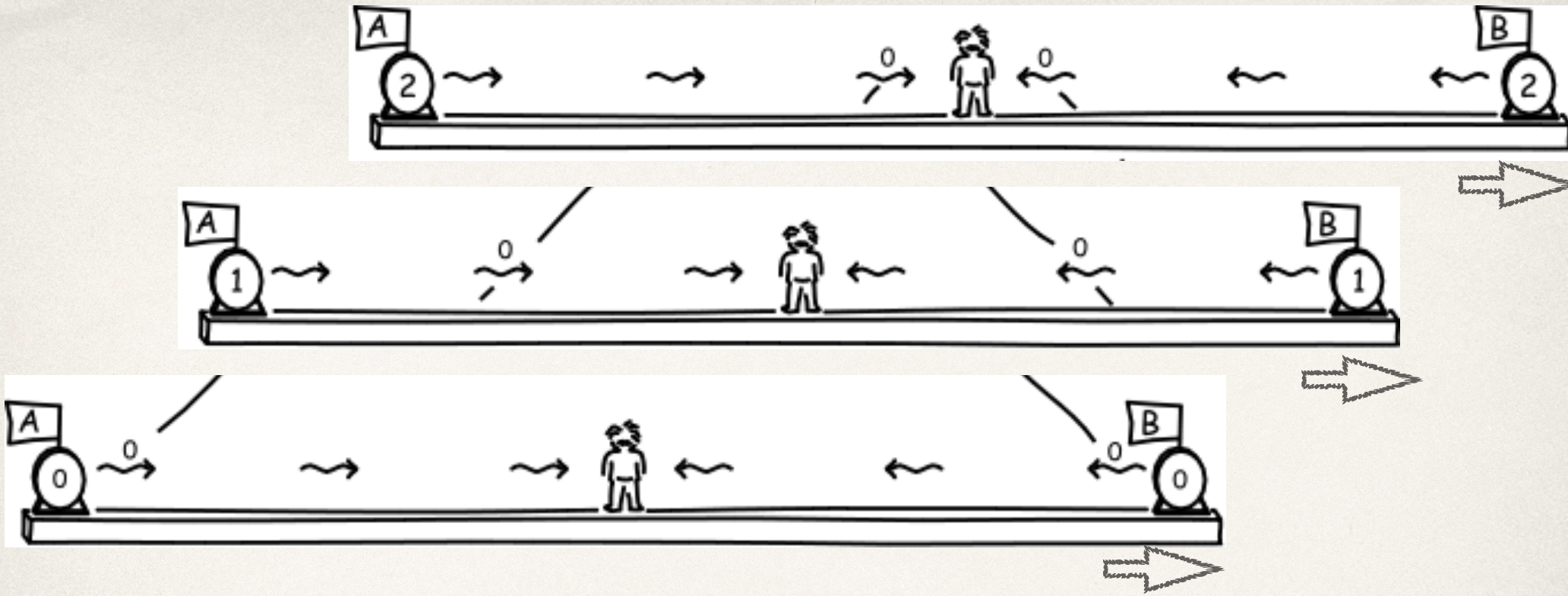
*E*vent **P2** = *pingpong ball leaves B when clock reports time 0 and moves right-to-left*

Assume **(1)** the **distance** *from A to the man-in-the-middle* and the **distance** *from B to the man-in-the-middle* are the **same**, say **2 meters**.

Assume **(2)** the *pingpong ball from A* and the *pingpong ball from B* **travel at the same speed,** say, **1 meter per second.**

It follows that **(3)** the *pingpong ball from A* and the *pingpong ball from B* will **reach** the man-in-the-middle at the same time **after 2 seconds**.

So, events **P1** and **P2** are **simultaneous** because the pingpong balls travel the same distance and reach the man-in-the-middle at the same time. The clocks at A and B are **synchronized** because they both report time 0 when **P1** and **P2** occur.



Now assume (4) that the **platform** on which the man-in-the-middle and the clocks stand is moving at **1 meter per second from left to right**. *The other assumptions are the same.*

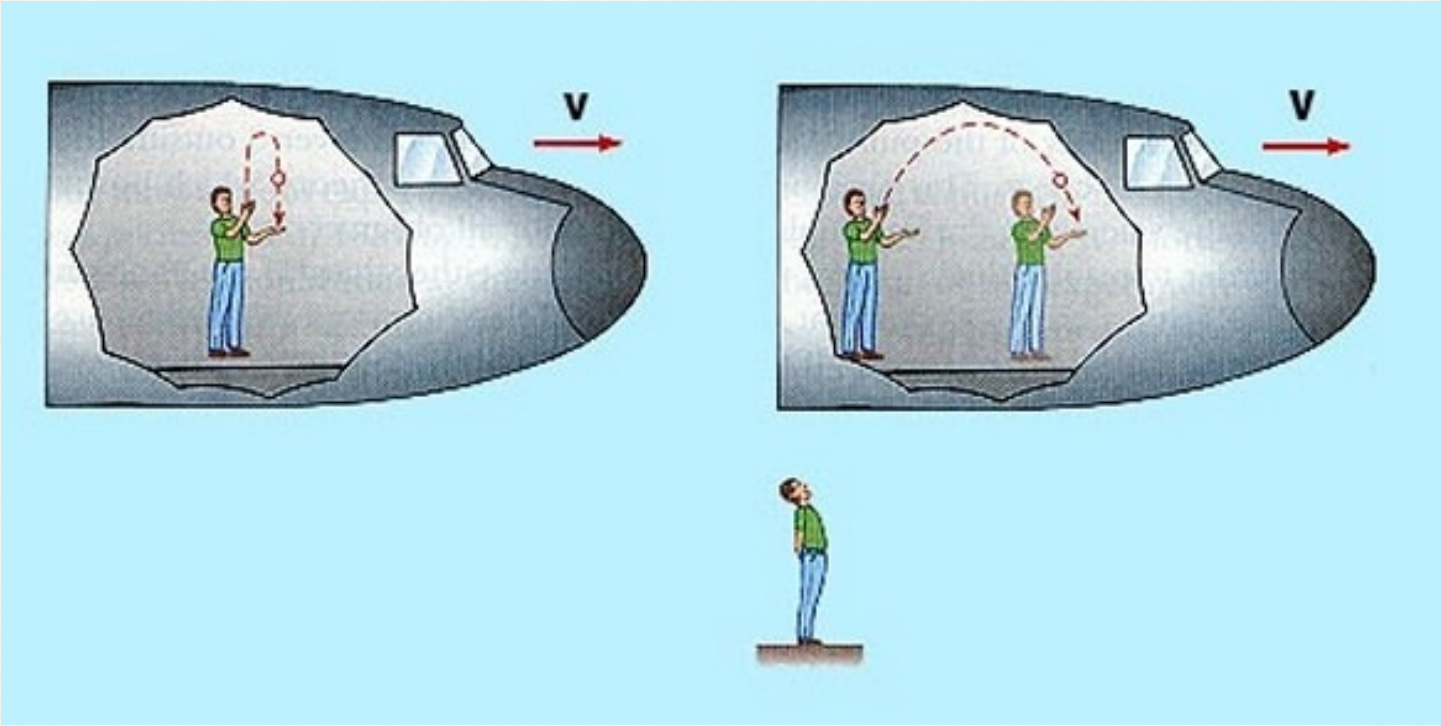
What is the speed of the pingpong ball leaving point A and moving right, from the viewpoint <u>outside</u> the moving platform?

2 m/s + 1 m/s = 3 m/s

What is the speed of the pingpong ball leaving point B and moving left, from the viewpoint <u>outside</u> the moving platform?

2 m/s - 1 m/s = 1 m/s

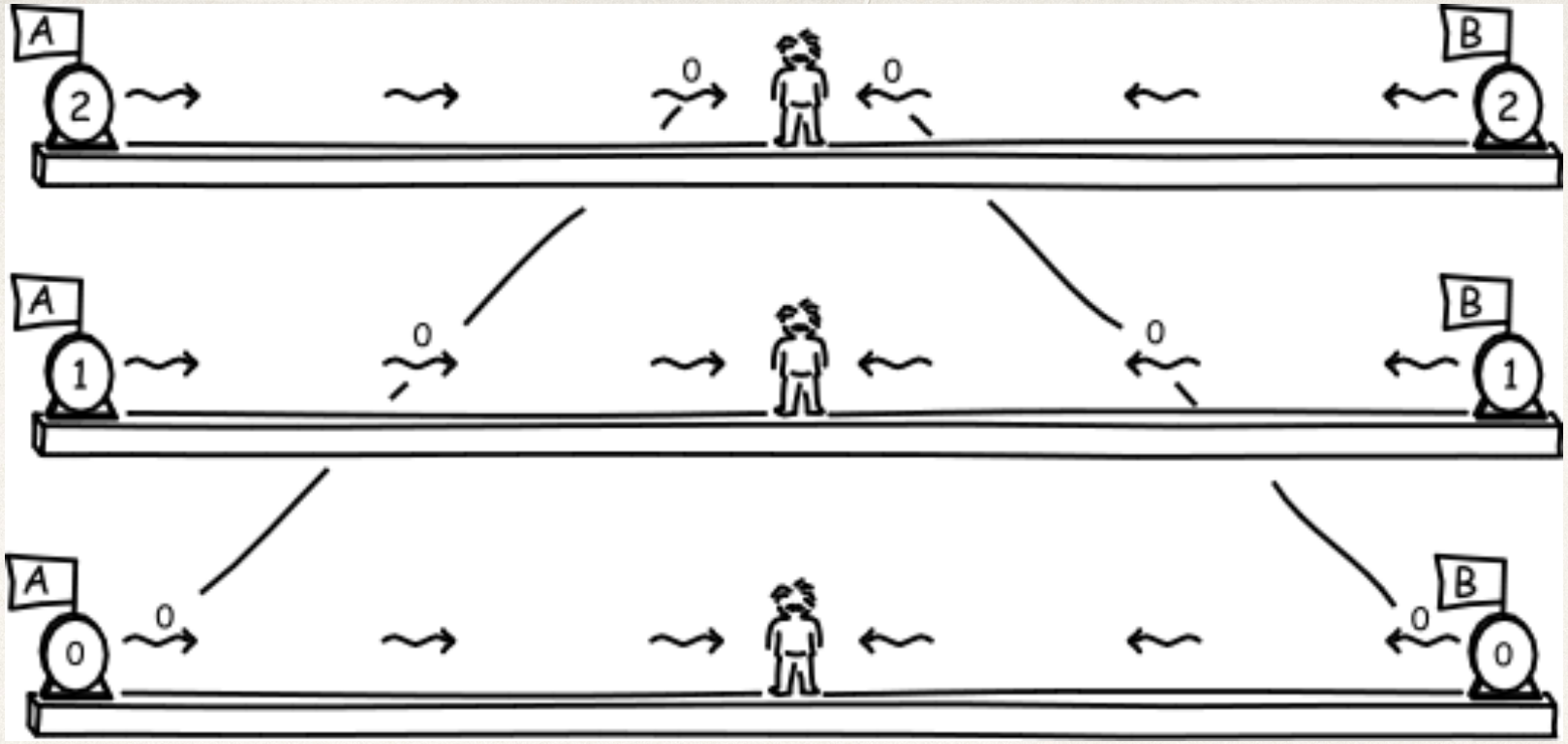
What You Have Seen is a Consequence of Galileo's and Newton's Relativity



Time flows uniformly for all observers, viewpoints, frames of reference, although velocity is relative.

Let's Now Consider a Special Case

We will now consider not a pingpong ball that travels at two meters per second, but a light signal that travels at the speed of light.



Event **L1** = *light signal leaves A when clock reports time 0 and moves left-to-right*

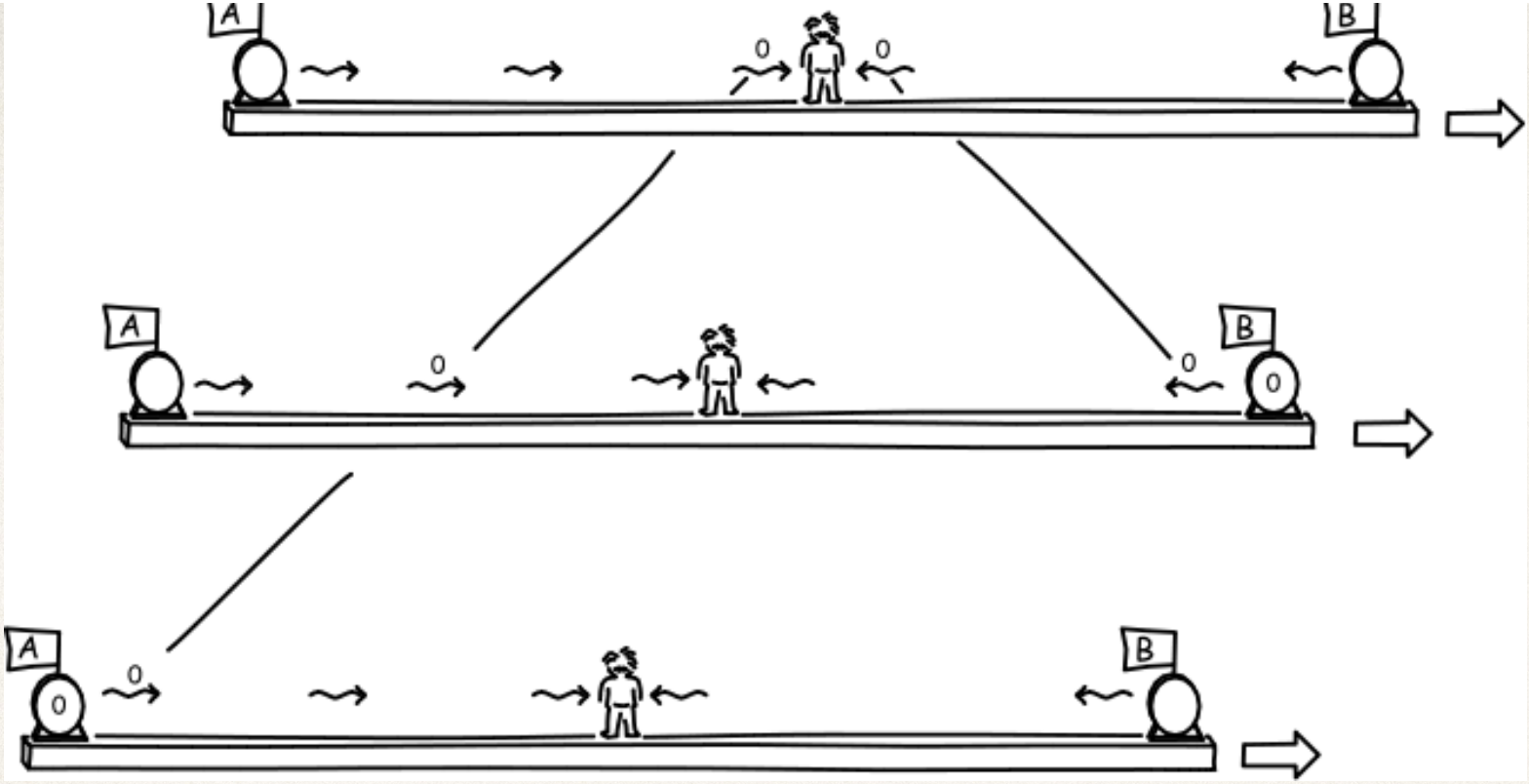
*E*vent **L2** = *light signal leaves B when clock reports time 0 and moves right-to-left*

Assume **(1)** the **distance** *from A to the man-in-the-middle* and the **distance** *from B to the man-in-the-middle* are the **same**, say **2 meters**.

Assume **(2)** the *light signal from A* and the *light signal from B* **travel at the same speed,** namely **the speed of light, call it c.**

It follows that **(3)** the *light signal from A* and the l*ight signal from B* will **reach** the man-in-the-middle at the same time.

So, events **L1** and **L2** are **simultaneous** because both light signals reach the man-in-the-middle at the same time. The clocks at A and B are **synchronized** because they both report the same time when **L1** and **L2** occur.



Now assume (4) the **platform** is moving at 1 meter per second **from left to right.** *The other assumptions are the same*.

What is the speed of the signal leaving point A and moving right, from the viewpoint <u>outside</u> the moving platform? Shouldn't it be **c + 1 m/s**?

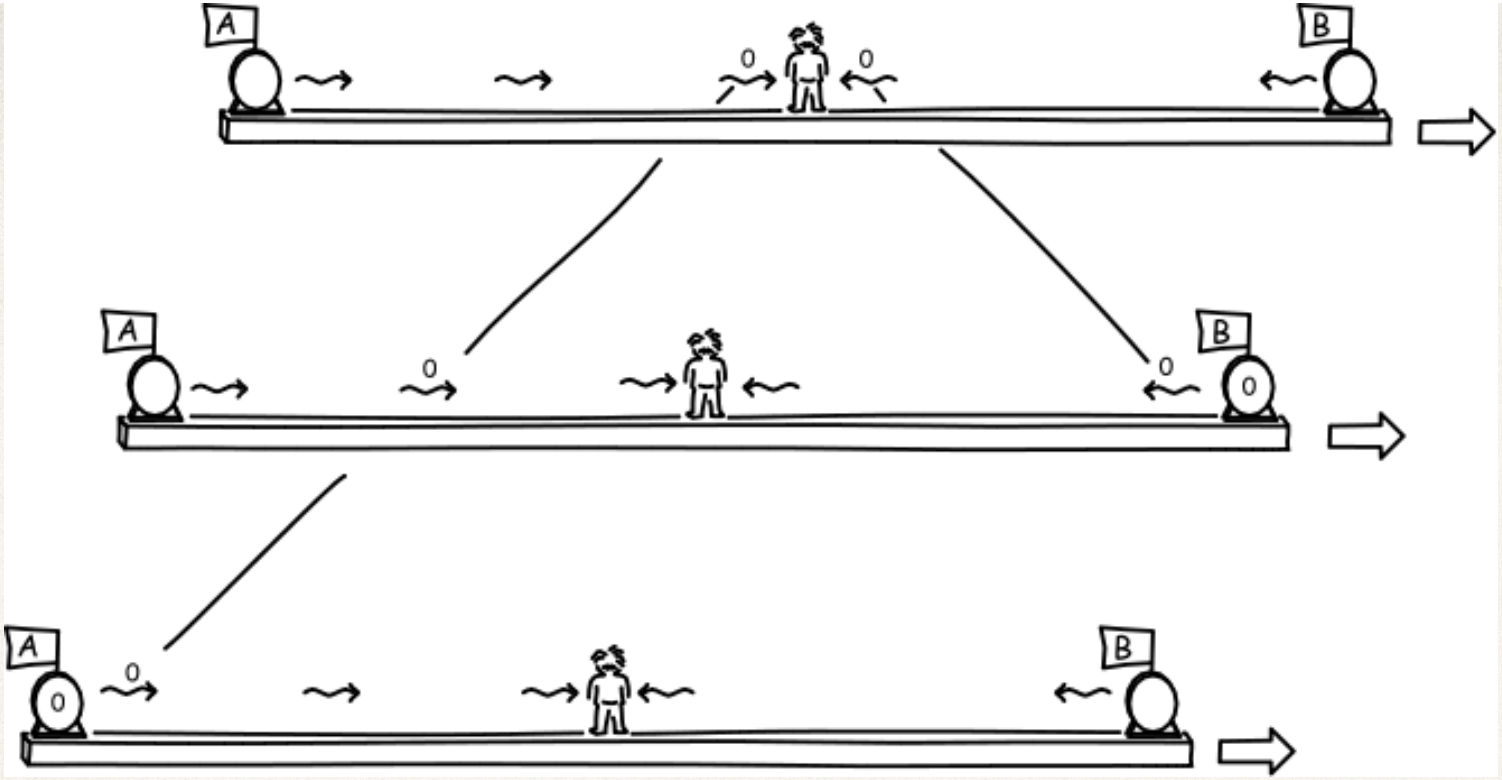
NO. *It is still* **c**.

What is the speed of the signal leaving point B and moving left, from the viewpoint <u>outside</u> the moving platform? Shouldn't it be **c - 1 m/s**?

NO. *It is still* **c**.

However Mysterious that Might Be, the Speed of Light (in a Vacuum at Least) Is **Constant Across Different Viewpoints**

In 1879 it was thought that light must propagate through a medium in space called ether. Michelson and Morley set up an experiment to detect the ether, by observing relative changes in the speed of light as the Earth changed its direction of travel relative to the sun during the year. But the two scientists failed to detect any change in the speed of light.



Again, assume (4) the **platform** is moving at 1 meter per second from left to right, (3) the signals reach the man-in-middle at the same time, and (2) the signals from A and B are moving at the speed of light, call it c.

> *From the viewpoint outside the moving platform*, the **signal from A** must cover a **greater distance** to reach the man-in-the-middle.
>
> *From the viewpoint outside the moving platform*, the **signal from B** must cover a **shorter distance** to reach the man-in-the-middle.

Now, if the speed at which both signals travel is the same, what does it follow?

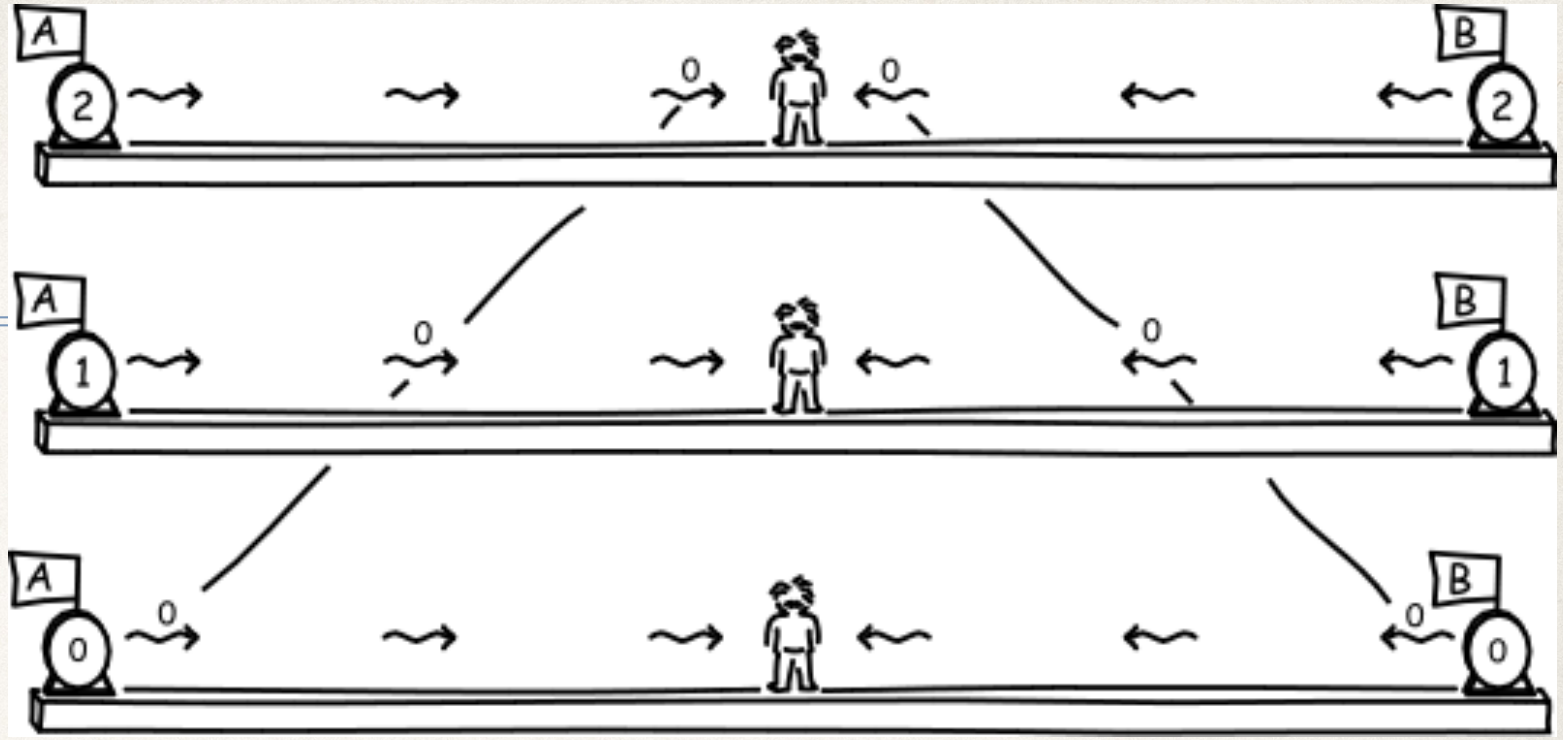
The *signal from A* must leave A **before** the *signal from B* leaves B. So, events **L1** and **L2** are **no longer simultaneous** *from outside the moving platform*.

If the Two Light Signals Could Move at Different Speeds, One Signal Could Be Faster than the Other. This Would Be the Obvious Conclusion According to Galileos' and Newton's Relativity

---

But Since the Speed of Light Is Constant Across Viewpoints, We Must Conclude that One Light Signal Left Earlier Than the Other

Just to be Clear



We considered:

Event **L1** = *light signal leaves A when clock reports time 0 and moves right*

Event **L2** = *light signal leaves B when clock reports time 0 and movies left*

We found that:

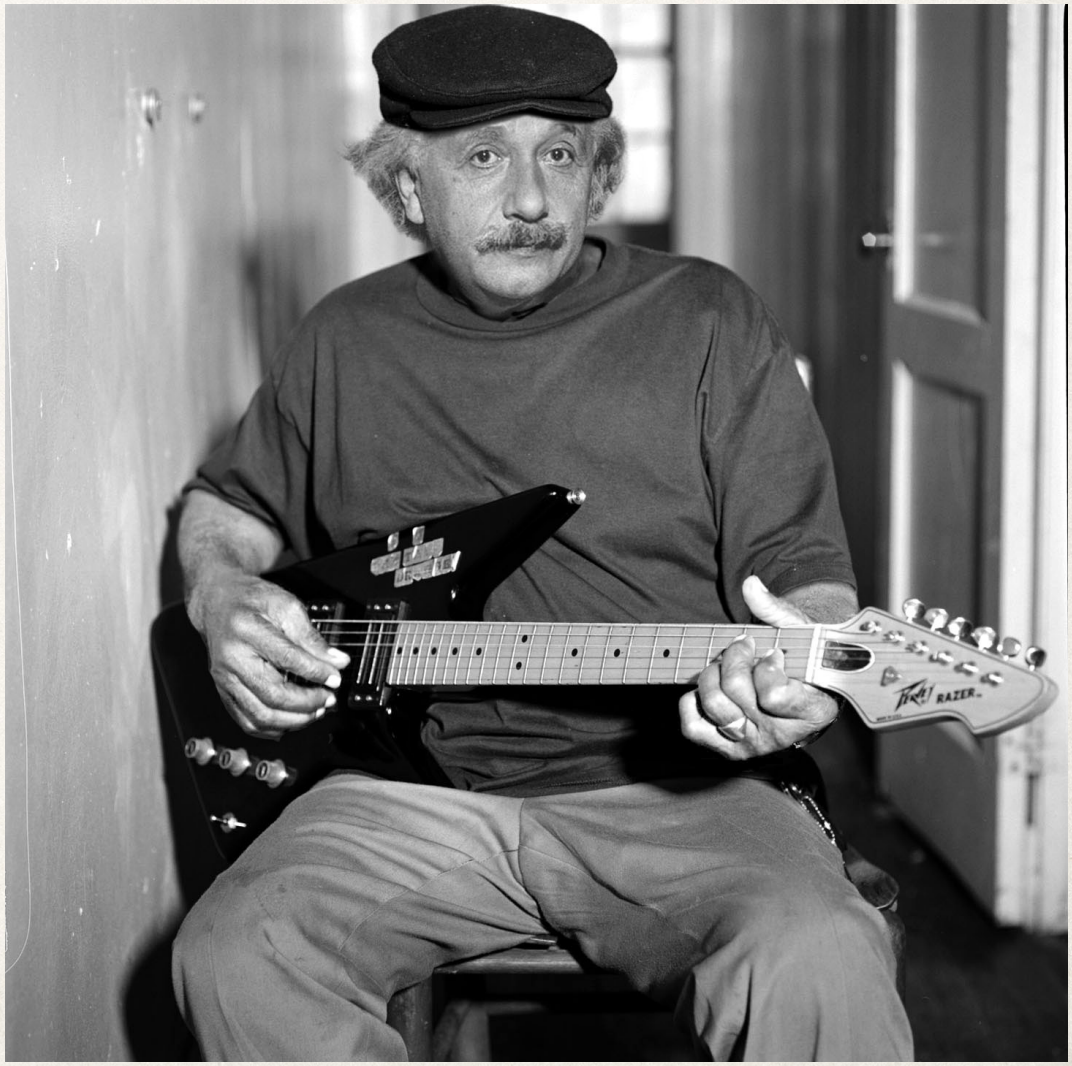
*E*vents **L1** and **L2** are **simultaneous** from the viewpoint <u>within</u> the platform.

*E*vents **L1** and **L2** are **not simultaneous** from the viewpoint <u>outside</u> the platform.

The Relativity of Simultaneity

The **simultaneity** of two events is **relative** to the viewpoint.

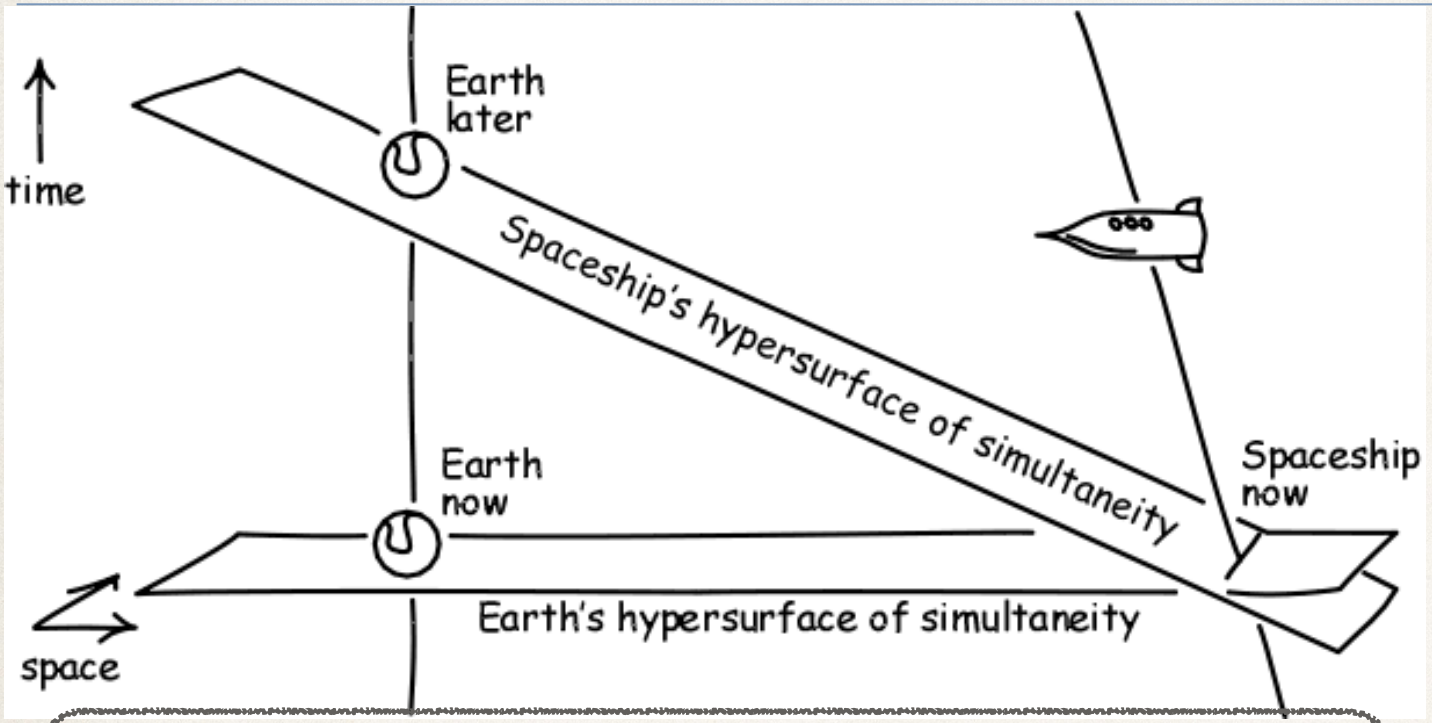
This is the main insight of Einstein's theory of special relativity.



What the Relativity of Simultaneity is Not

The relativity of simultaneity is not about our psychological perception of time and of when events occur in time. The relativity of simultaneity is something that follows from the laws of physics. This relativity is not about experiences or perceptions; it is about the physics of time (i.e. about how physics describes time and events in time independently of our perceptions)

(1) What Does the Relativity of Simultaneity Tell us About Time?



An event that belongs to the future **from the Earth viewpoint** is instead part of the present from the Spaceship Viewpoint.

A conclusion we can drawn here is that *the present is relative, not absolute*. There is not one present, but possibly many "presents".

If You Want to Know More About The Special Theory of Relativity…

"Einstein for Everyone" by John Norton

http://www.pitt.edu/~jdnorton/teaching/HPS_0410/index.html

(2) What Does the Relativity of Simultaneity Tell us About Time?

If, as Special Relativity suggests, there is not one present, but possibly many "presents", we can think of time **not** as a **uniform flow** but rather as a **block** in which all time instants coexist.

Erasing The Flow of Time

Alice was hoping for a white Christmas, but when the day came she was disappointed that it only rained; however, she was happy that it snowed the following day.

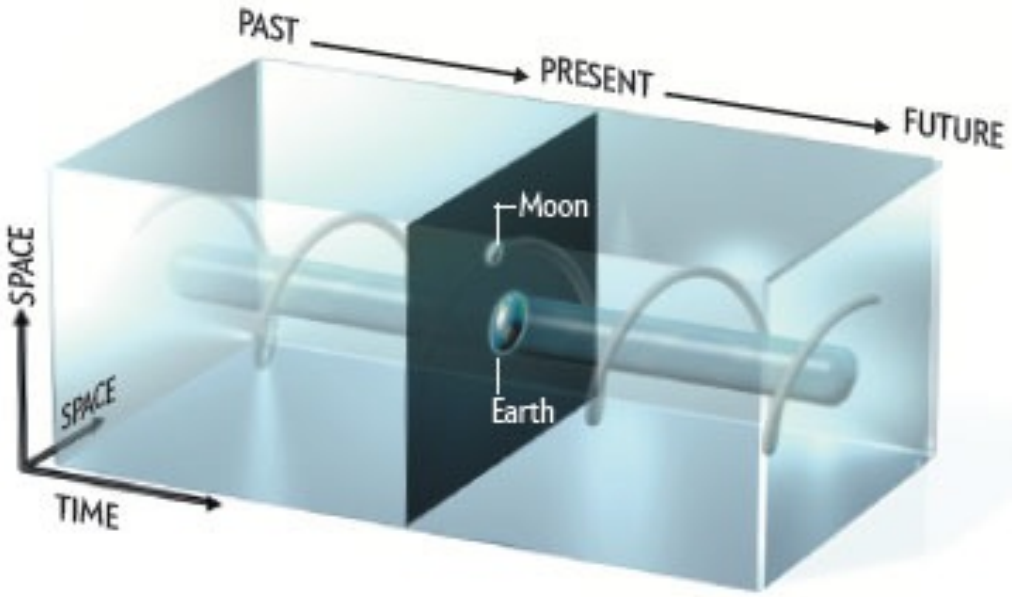
December 24: Alice hopes for a white Christmas.

December 25: There is rain. Alice is disappointed.

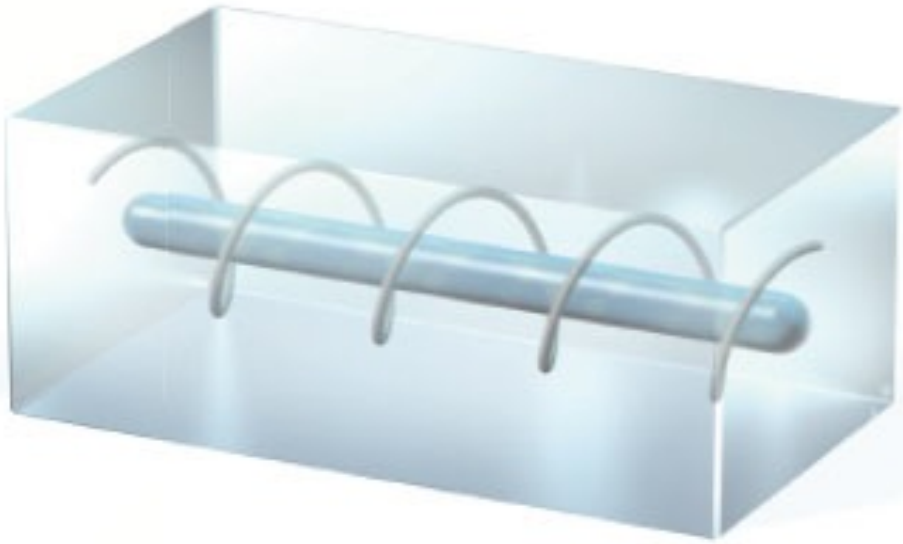
December 26: There is snow. Alice is happy.

In the second description the flow of time has been eliminated. Every event is described in the present tense and is assigned a date. There is no flow of time.

Time as Flow *versus* Time as Block



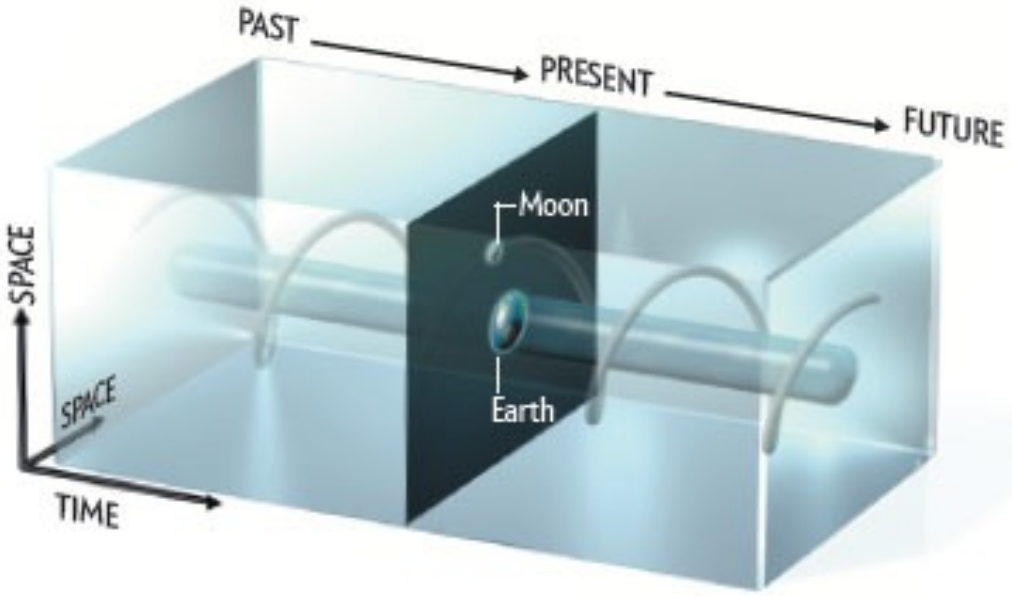
Conventional view: Only the present is real



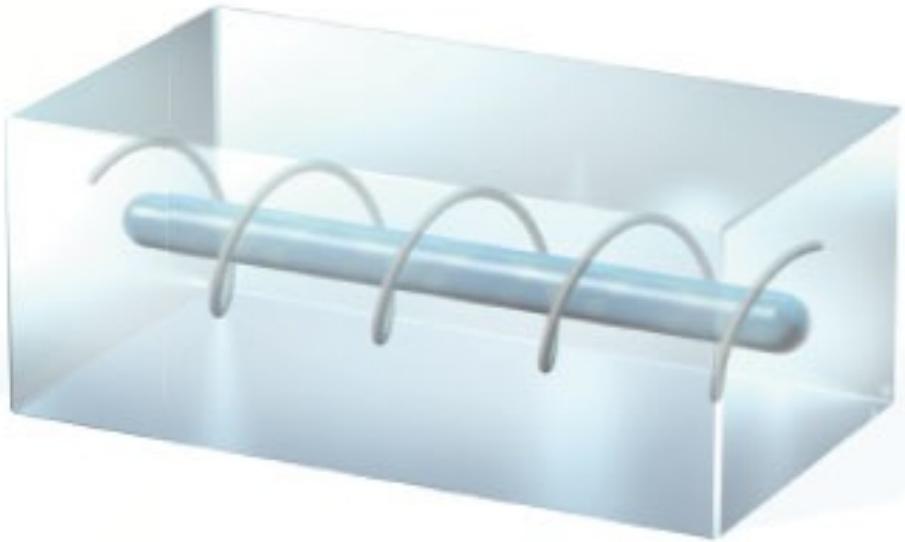
Block universe: All times are equally real

Which View of Time is Correct?

The Two Views Are Complementary



Conventional view: Only the present is real



Block universe: All times are equally real

Time-as-a-flow better aligns with our psychological experience of time.

Time-as-a-block better aligns with physics and Special Relativity.

***Question**: How does the psychological experience of **time as flow** arise from the physics of **time as a block**?*