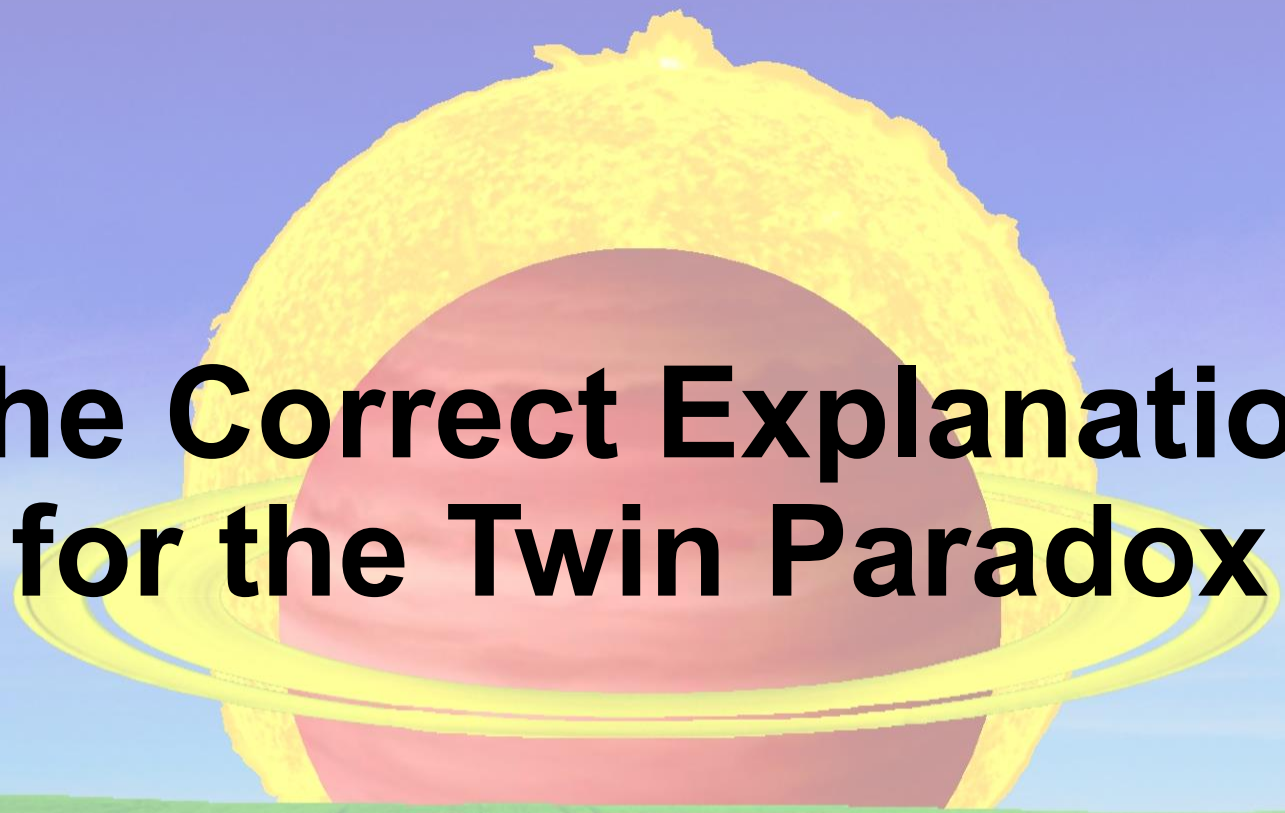
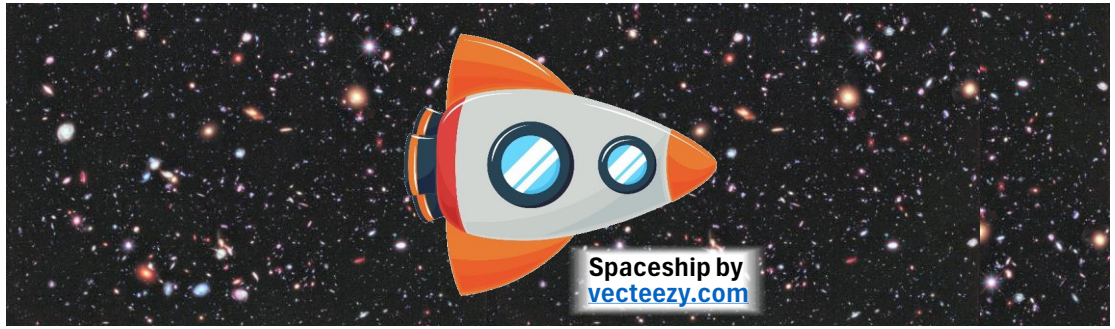


The Correct Explanation for the Twin Paradox

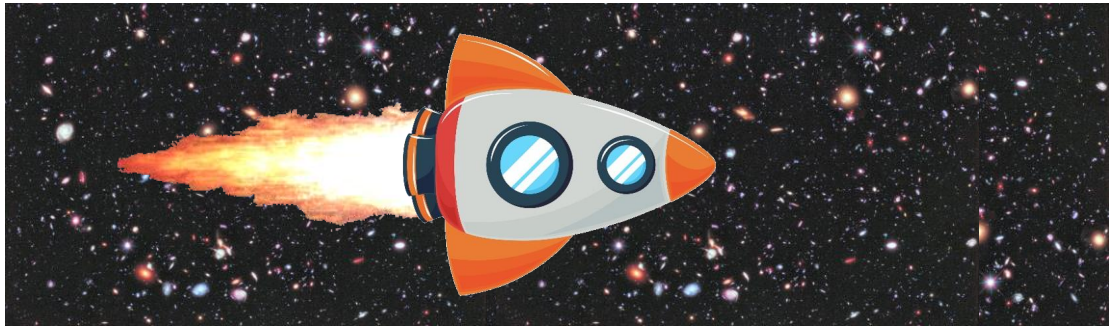
Terry Bollinger

August 18, 2025

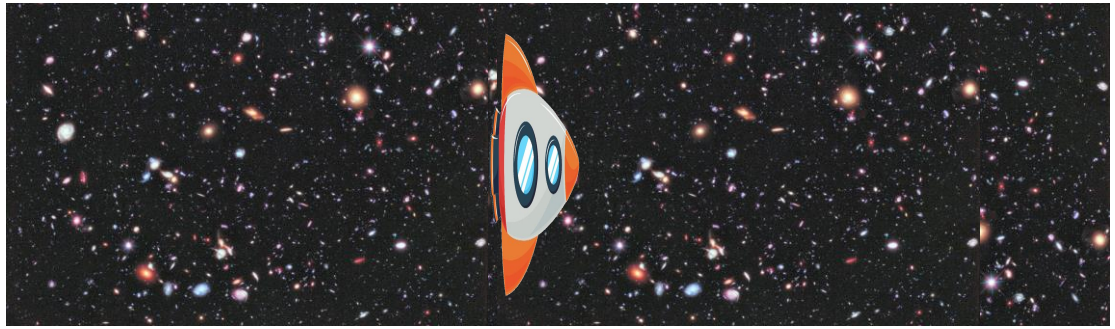
Length Contraction and Time Dilation in Special Relativity



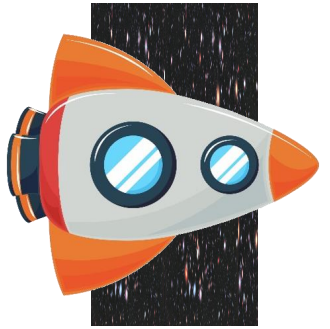
Ship at rest relative to the universe
Lengths = ***same***, clock ticks = ***same***



The ship accelerates *fast*, then coasts



Universe's View:
The **ship is shorter**, and
its **clocks tick slower**



Ship's View: By **Poincaré Symmetry**,
the **universe should be shorter**, and
its **clocks should tick slower**

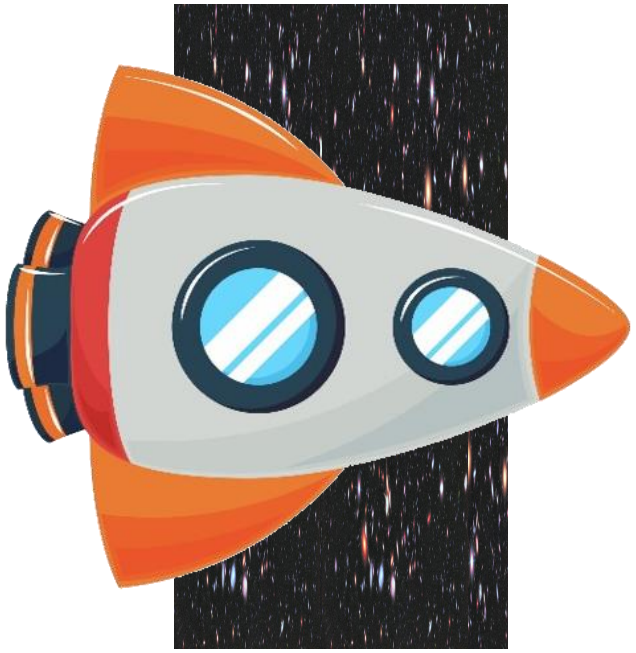
What is a Symmetry? The Role of Mirrors in Physics

- At every level, physics is like a delightfully complicated house of mirrors
- Hierarchies of reflections create the complex behaviors of relativity, quantum, and particles
- For **Einstein's Special Relativity**, the **Poincaré Symmetries** are the deepest set of "funhouse mirrors." (Lorentz is a subset.)
- Both **length contraction** and **time dilation** (slower clocks) are Poincaré Symmetries
- Poincaré Symmetry says moving systems see each other identically. **But is that true?**

Does Moving Fast Freeze the Entire Universe?

Despite the ship's tiny size, the Poincaré Symmetries say:

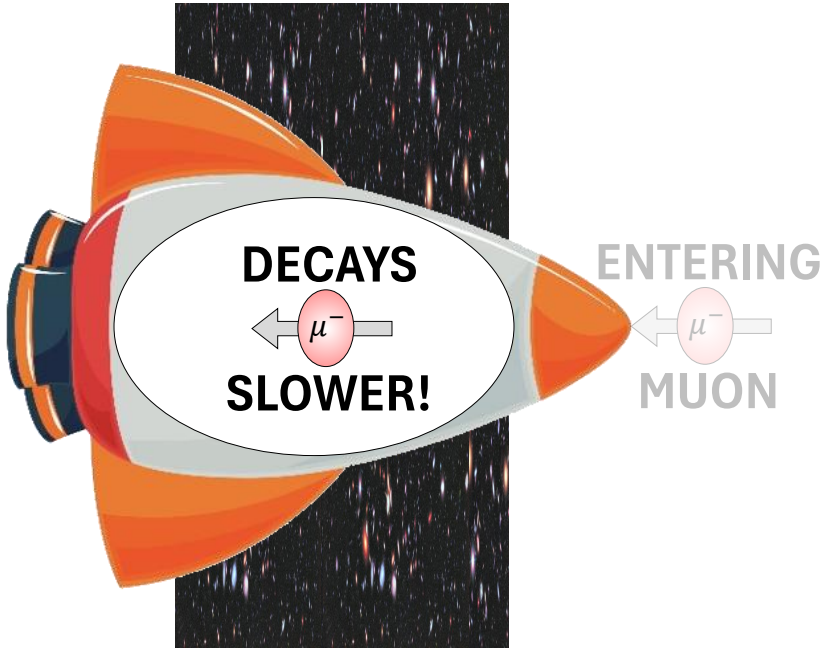
(a) The **entire universe** must be shorter, and
(b) That **all clocks in the universe must tick slower**.



Poincaré Verified! Clocks from Outside Age Slower

All experiments done inside the ship **confirm** Poincaré!

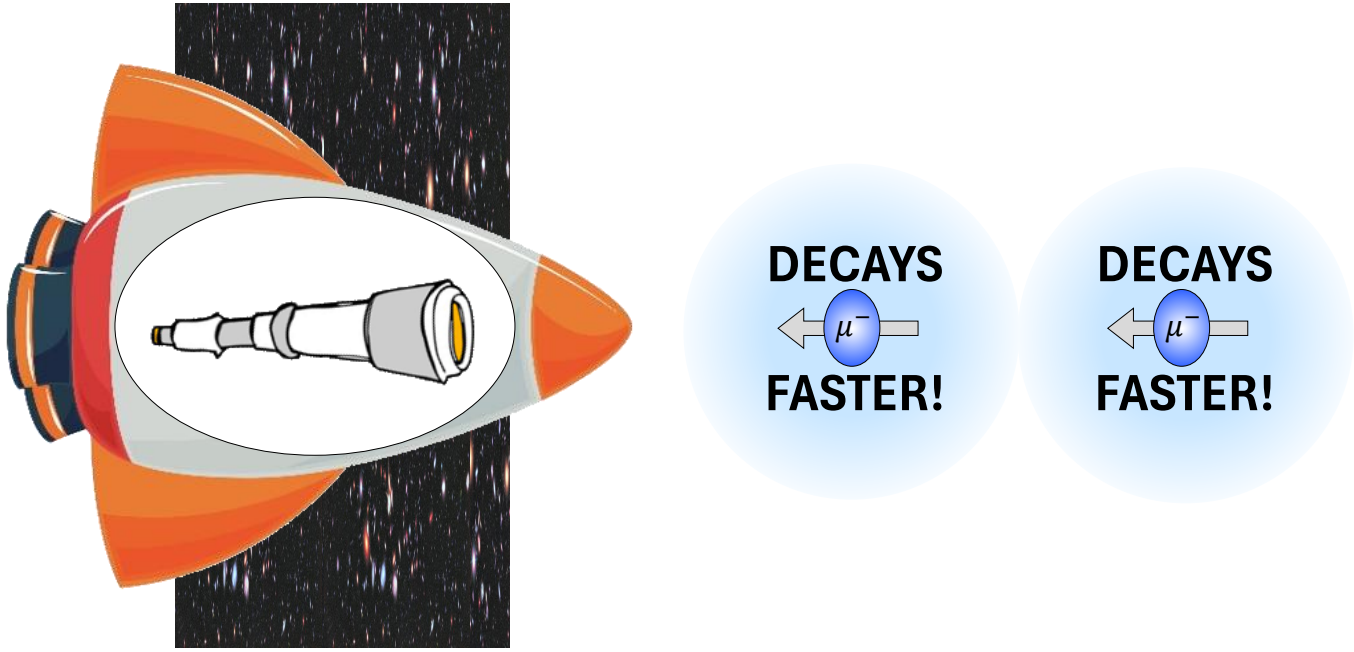
Muons (think “particle clocks”) entering the ship’s front “tick slower” as they pass through the interior of the ship.



Poincaré Contradicted! Clocks in Front Age Faster

Forward observations of the universe **contradict** Poincaré!

Blue-shifted light from muons in front says they *decay much faster* than normal. (Blue shift is the *opposite* of time dilation.)



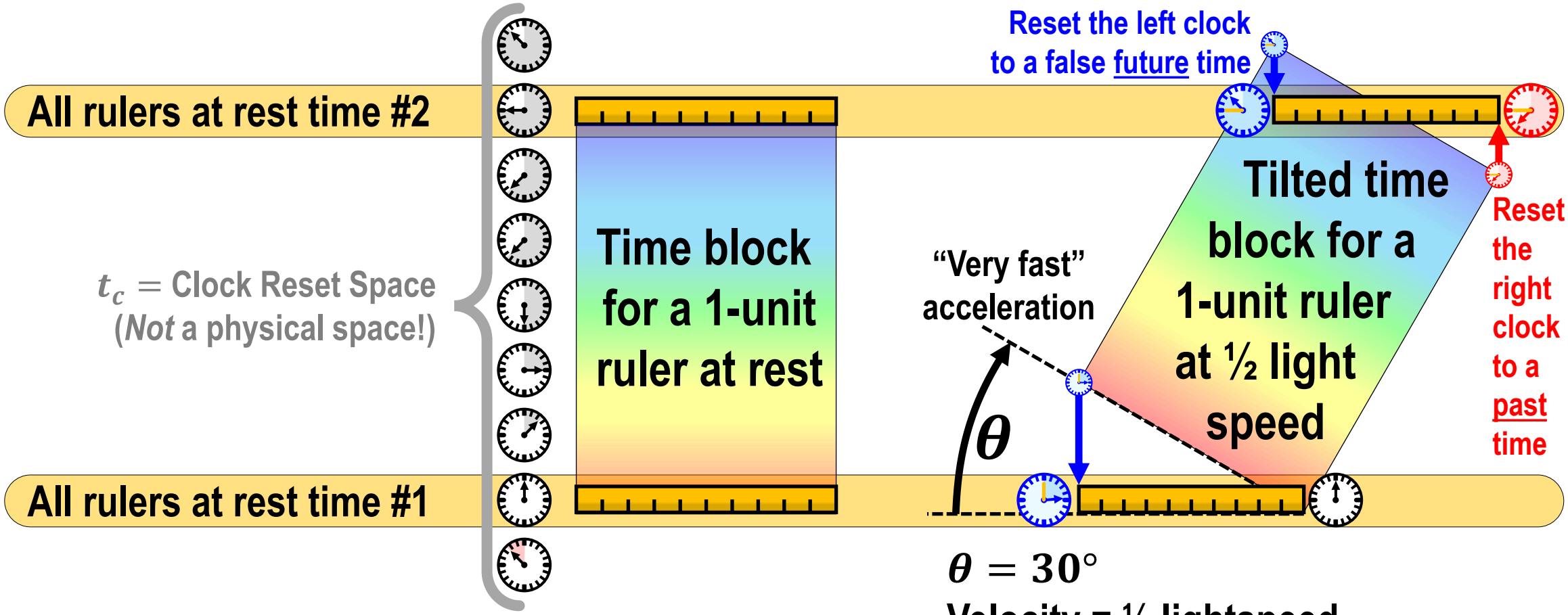
Twin Resolution: There Are Two Symmetries in Play

Resolution: The house-of-mirrors called Poincaré Symmetries only applies *inside* a small constructed Poincaré "bubble" that moves through a vastly larger interpretive symmetry space

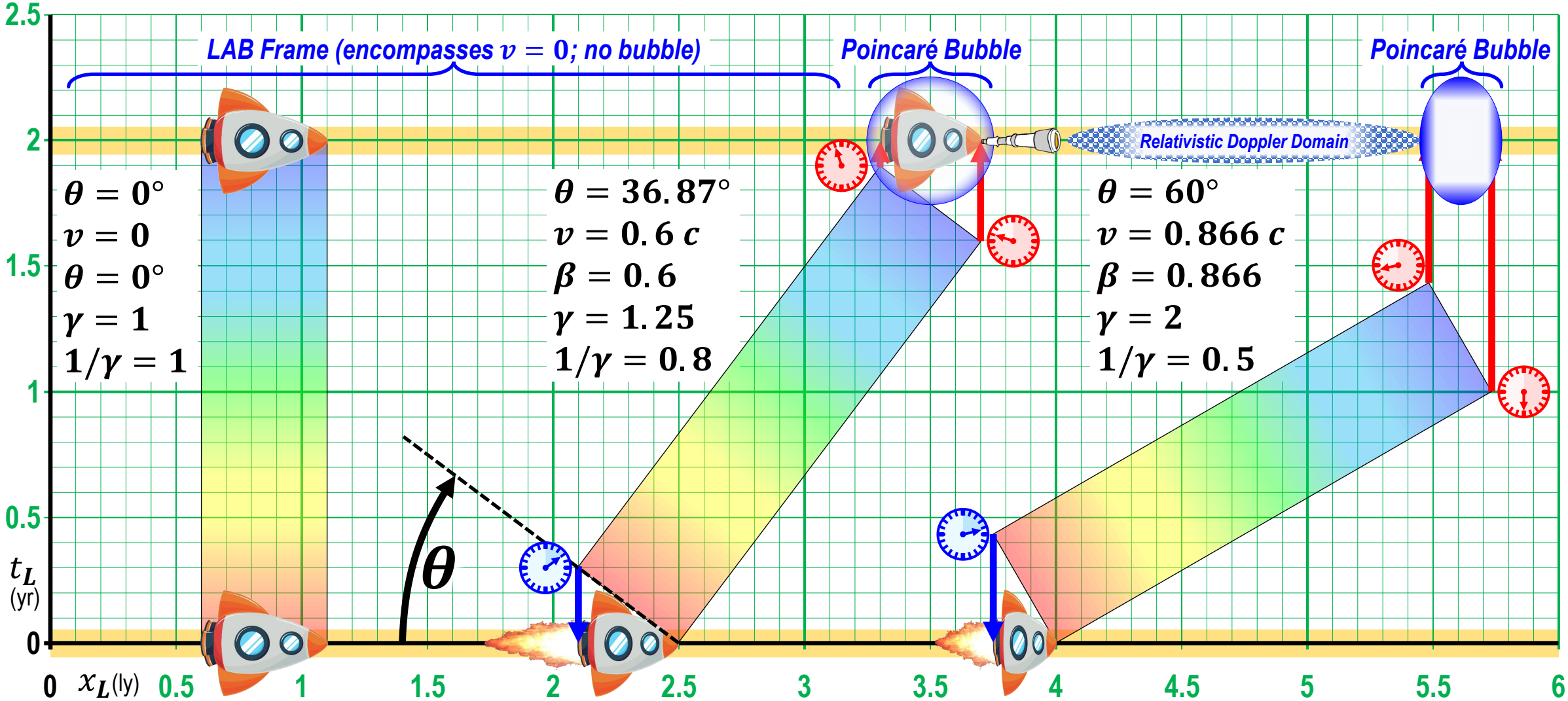
Poincaré Bubbles (PBs) emerge *after* manually **altering** ship components. Only participating components "see" the new symmetry.

Relativistic Doppler symmetries apply to all *regions* outside the bubble. They are **interpretive only** and thus do not alter the outside world.

SR Made Easy: Tilted-Block Lorentz Calculator

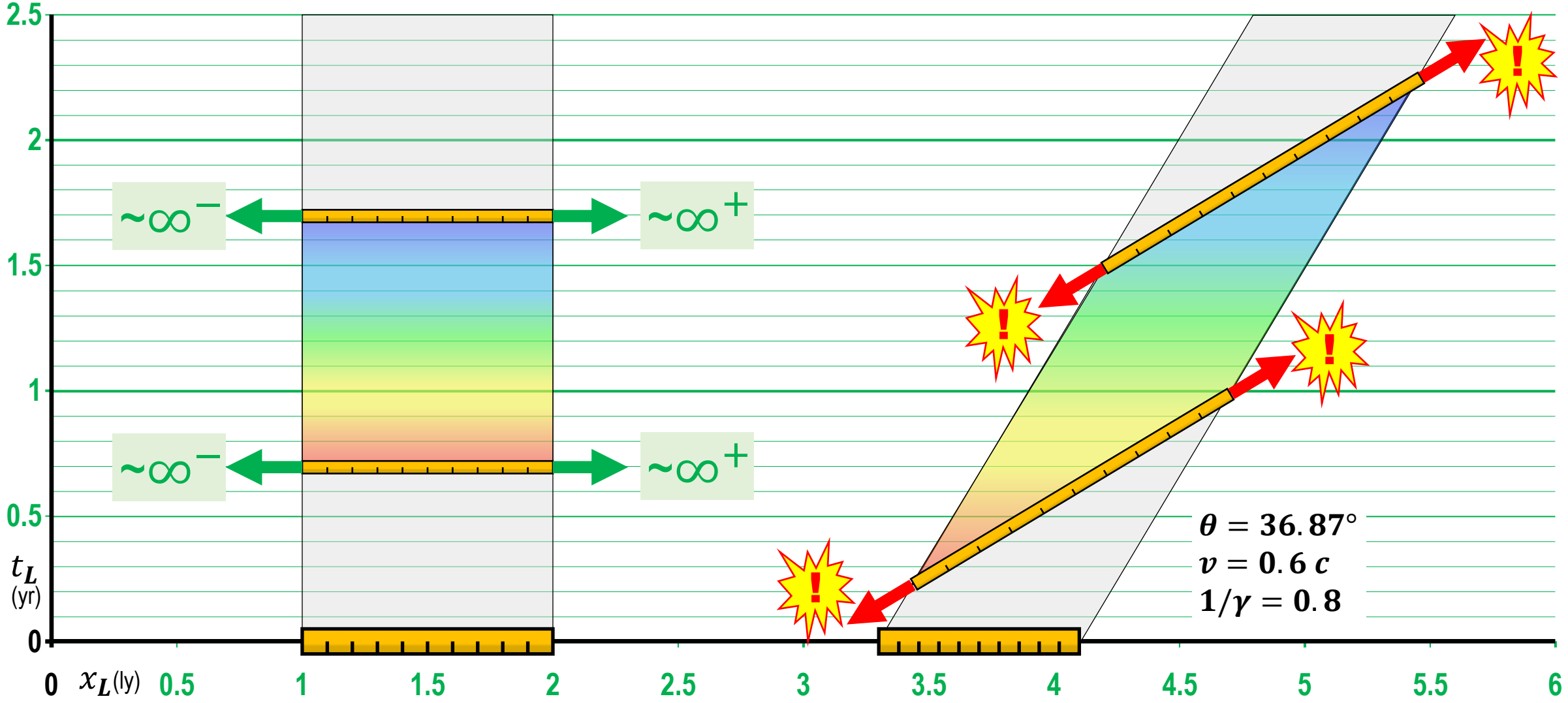


Using Tilted Blocks to Build Poincaré Bubbles

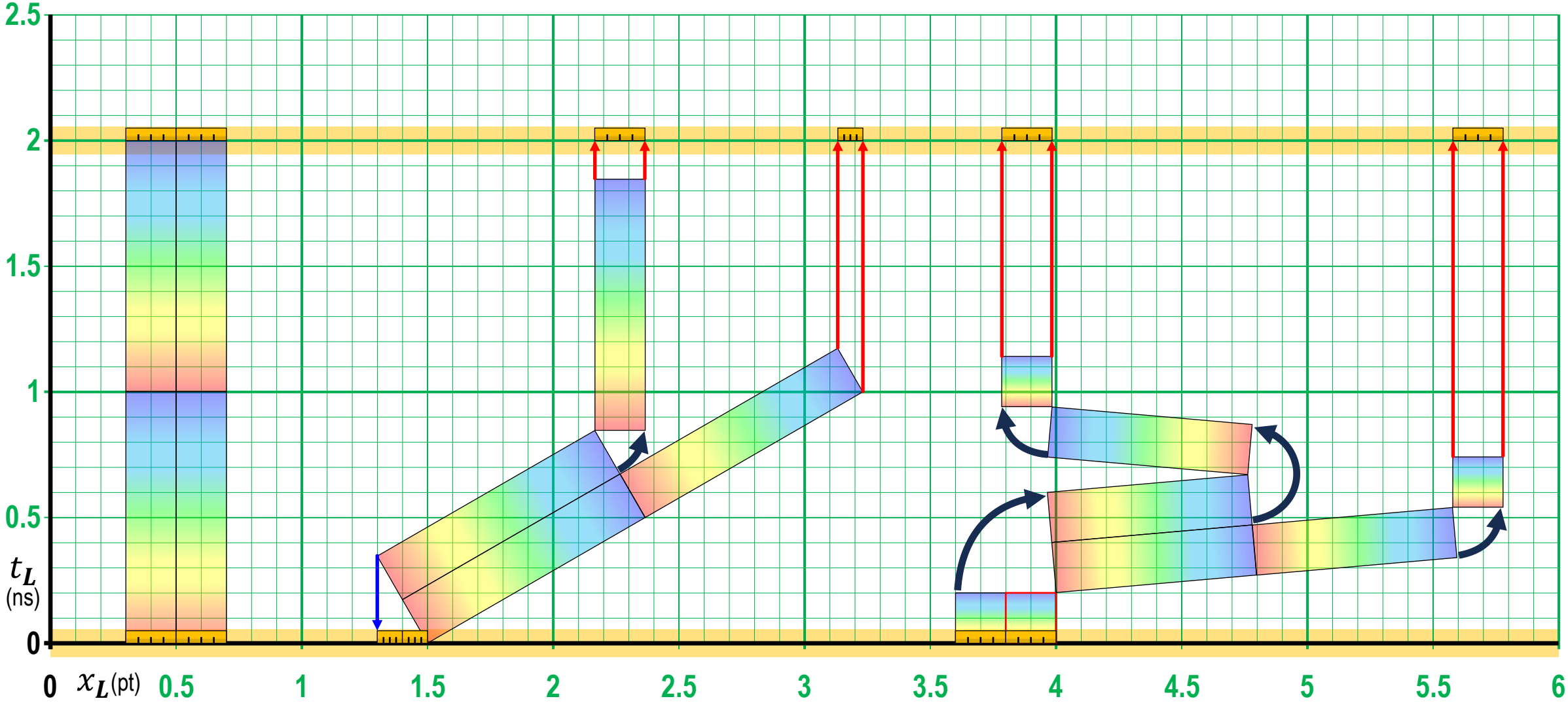


$$\theta = \cos^{-1}\sqrt{1-\beta^2} \qquad v = c\sqrt{1-\cos^2\theta} \qquad \beta = \sqrt{1-\cos^2\theta} \qquad \gamma = 1/\cos\theta \qquad 1/\gamma = \cos\theta$$

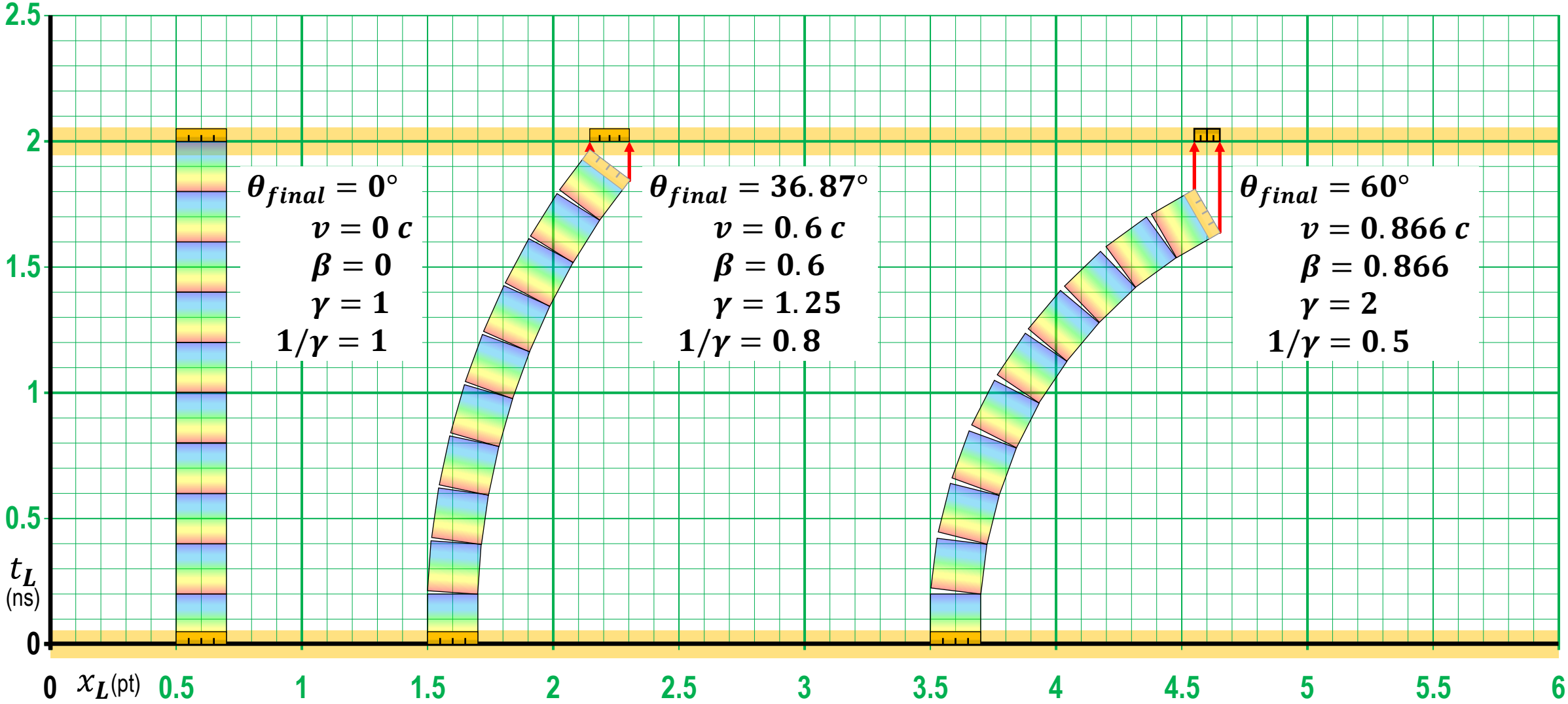
The Bubble Problem: Tilted Rulers Don't Extend



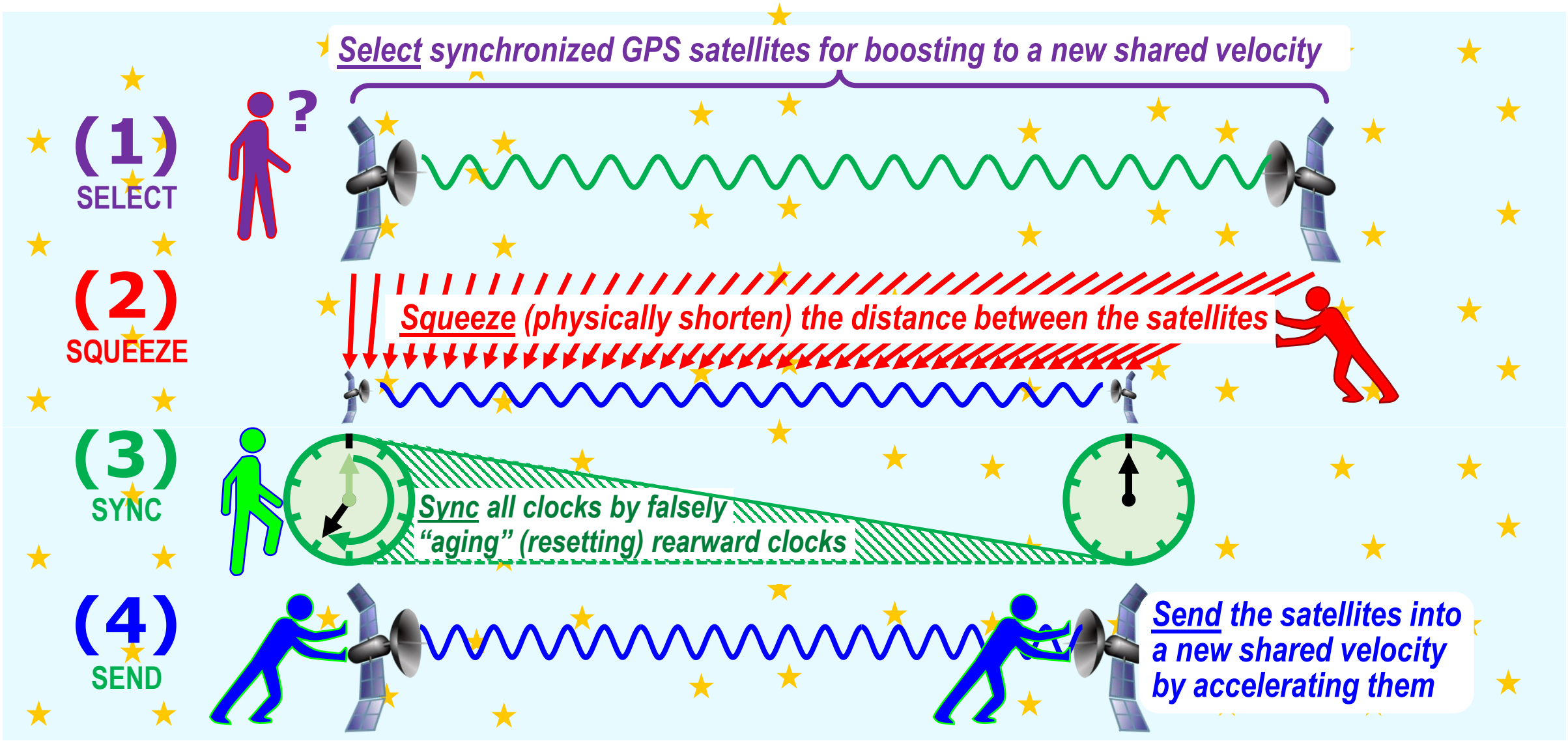
Cascading Time Block Tilts



Minkowski's Proper Time τ As Adding Tilt Blocks

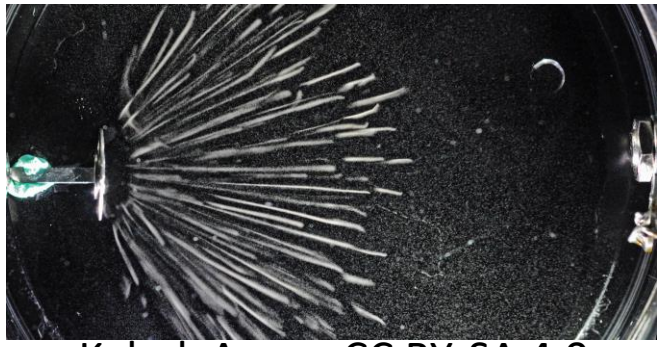


Building A Large Poincaré Bubble Requires Engineering

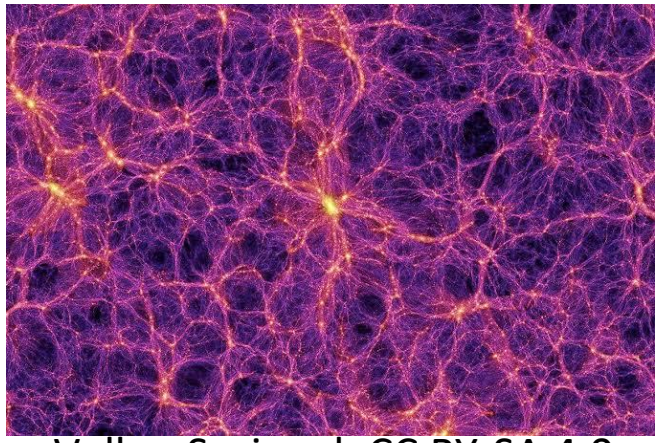


Is There a Poincaré "Bubble of All Bubbles"?

- Acceleration — creating a Poincaré Bubble or PB — is messy. It's *not* a simple scalar "boost."
  - Particle PBs form instantaneously. The algebraic boost model works well for these simple cases.
  - Cosmic web PBs require billions of years to form, if they form at all. (This impacts dark matter theory.)



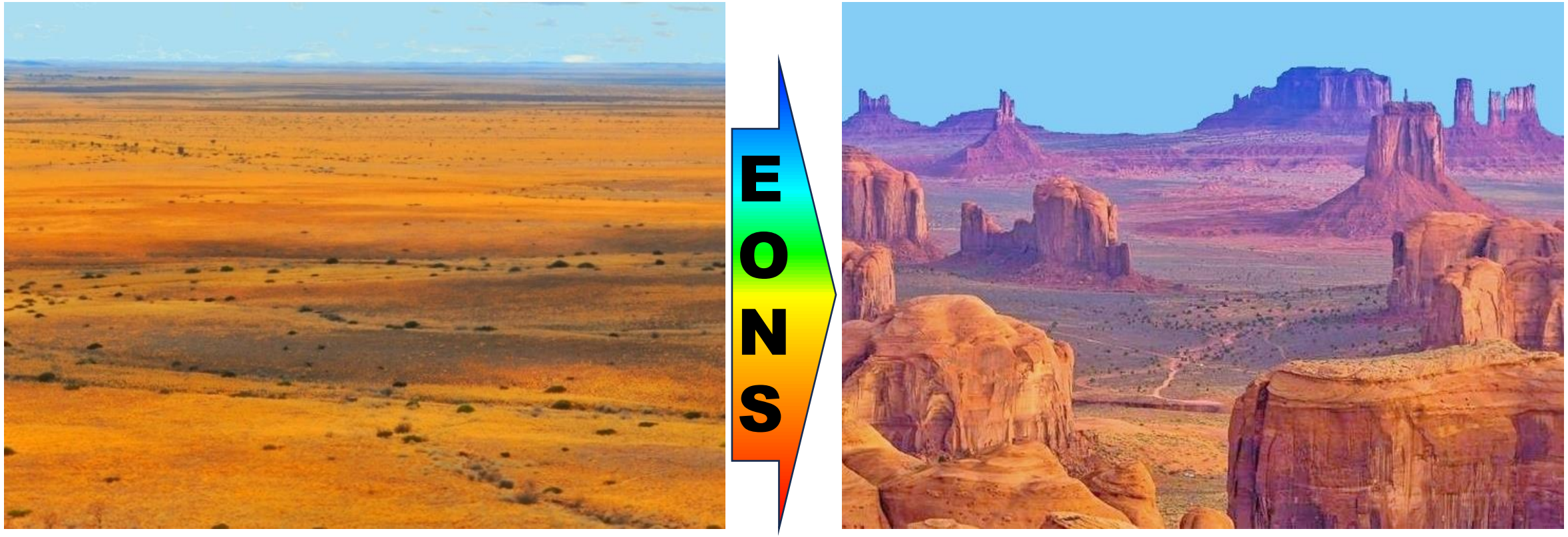
Kebuk Awan, CC BY-SA 4.0



Volker Springel, CC BY-SA 4.0

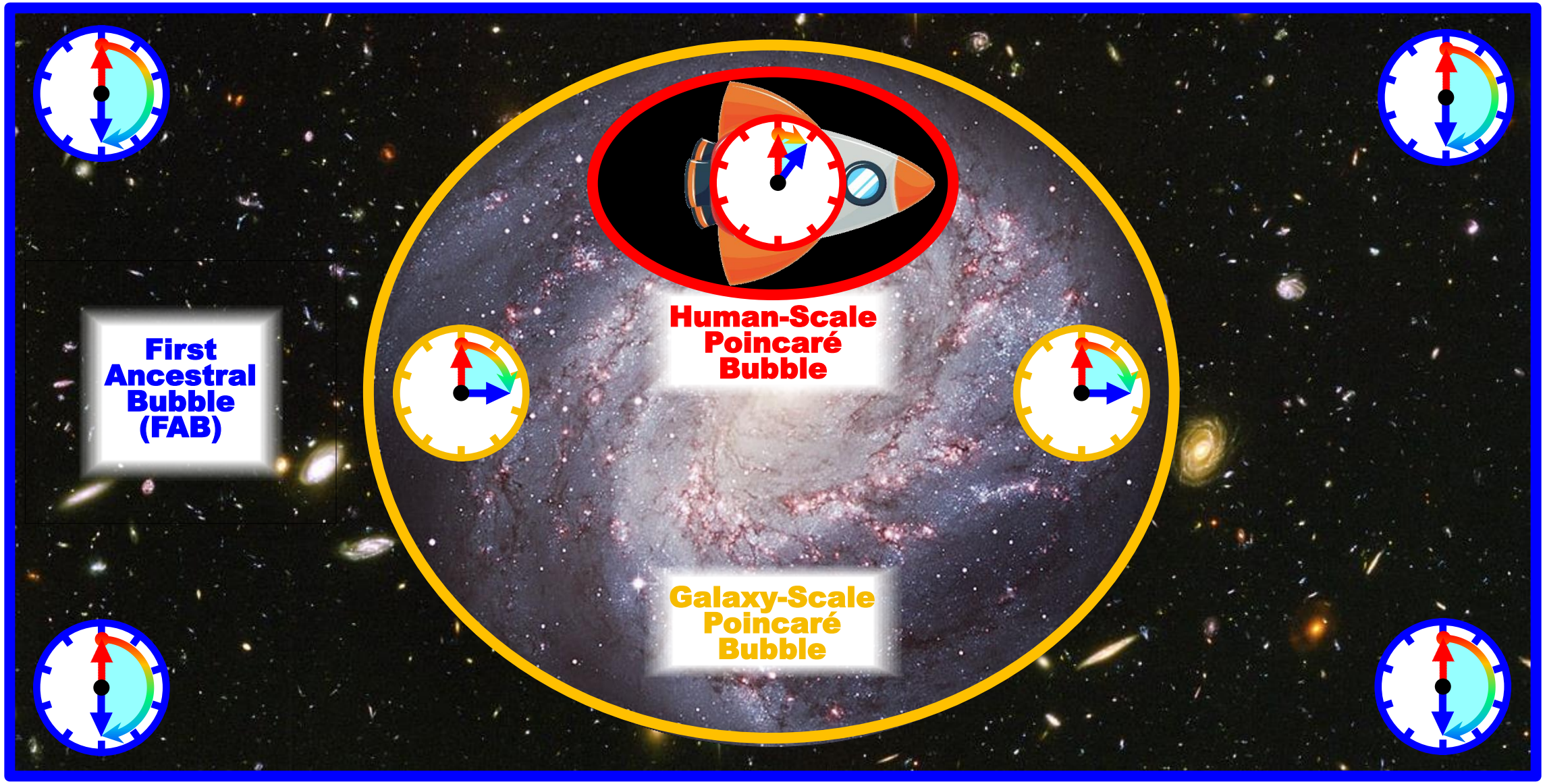
- PB creation, evolution, and termination always stay fully visible within the larger and faster originating PB. (Analogy: Spaces in games.)
  - Poincaré Bubbles have multiple usable applicable coordinates: Local only, Latest Ancestral Bubble (LAB), or First Ancestral Bubble (FAB = CMB),
  - FAB "bubble of all bubbles" enables universal time (no "block" universe).

Poincaré Bubbles Divide Spacetime Into Fractal "Mesas"

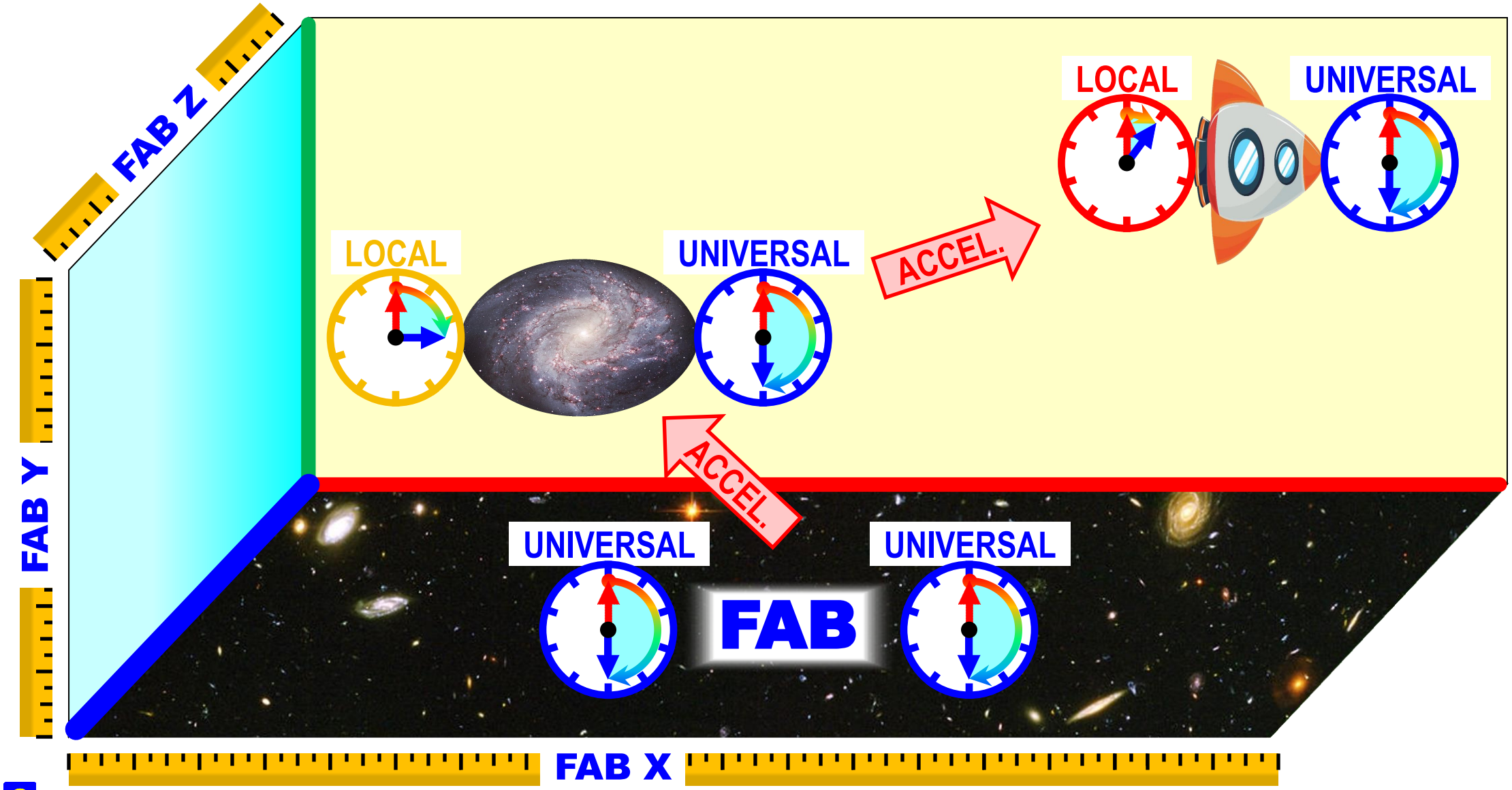


- Just as isolated mesas break up ground level from an earlier shared plain, acceleration breaks up the fastest time into hierarchies of slower local bubbles.
- The First Ancestral Bubble (FAB) is roughly the Cosmic Microwave Background (CMB). It is the oldest, largest, and fastest Poincaré spacetime bubble.

The Poincaré Bubble Hierarchy: Biggest, Oldest = Fastest



Universal First Ancestral Bubble (FAB) Coordinates



Why Don't Textbooks Teach Poincaré Bubbles?

- Overextending the ranges of the Poincaré Symmetries dates back to Einstein (multiple minor math errors in 1907, 1911)
- Excessive reverence caused the next century to brush off known corrections (e.g., in GPS satellites) as "engineering details."
- The "infinities are free" Hilbert school aggravated the problem by assuming all math symmetries have infinite ranges (violates c)
- Physically meaningful symmetries fall into two categories:
  - **Constructed symmetries** (bubbles) require *altering material objects*
  - **Interpretive symmetries** (spaces) change only *how you interpret data*
- **Constructed symmetries can expand only up to lightspeed**

The Three Errors That Undermined Einstein's Symmetries

(1) Objects suffer no permanent changes from being set into motion and brought to rest. **[FALSE]**

> "1) This conclusion [that the coordinate transformation equations are symmetric in both frame views] is based on the physical assumption that the length of a ruler and the speed of a clock do not suffer any permanent change as a result of these objects being set in motion and brought to rest again."

— A. Einstein, 1907. Page 420, Section 3, Footnote 1) in *Coordinate-Time Transformation*.

(2) Two inertial frames can share the same coordinate origin without creating paradoxes. **[FALSE]**

> "… choose as the starting point of time in both systems the moment at which the coordinate starting points $(t,x,y,z)=(0,0,0,0)$ and $(t',x',y',z')=(0,0,0,0)$ coincide;"

— A. Einstein, 1907. Page 418, Section 3 in *Coordinate-Time Transformation*.

(3) Declaring forward and backward lightspeeds to be identical causes no paradoxes. **[FALSE]**

> "… since … the lack of a preexisting universal time definition makes it fundamentally impossible to measure any speed … we are entitled to make just such an arbitrary stipulation … : The speed of light … in a vacuum from A to B is the same as from B to A"

— A. Einstein, 1911. Page 8 of *The Theory of Relativity*.

A Small But Impactful Math Correction

Einstein's equation for translating time coordinates in special relativity…

$$t' = \gamma\left(t - \frac{v}{c^2}(x)\right)$$

… needs one more parameter, $l = \text{length}$, to work in **all** situations:

$$t' = \gamma\left(t - \frac{v}{c^2}(x - l)\right)$$

We don't notice because the point approximation of pretending moving objects have no length works well for most lab situations.

The Correct Solution: Fix Special Relativity

- Einstein created the Twin Paradox via math errors
- Casual use of Poincaré symmetries made it worse
- Critical: Metric spaces are information constructs and thus must respect matter and lightspeed limits
- Two symmetry types: constructed and interpretive
- Acceleration away from a viewer *always* slows time
- LAB xyzt enables correct multi-frame time tracking