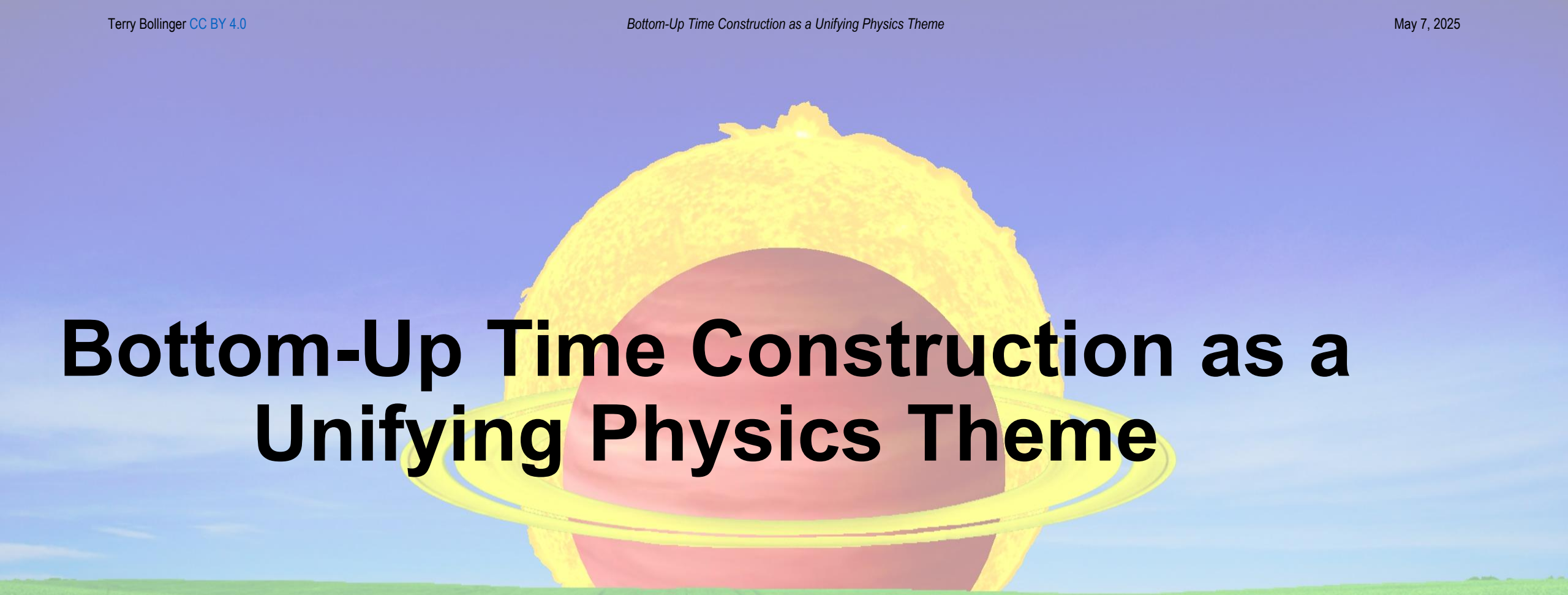


Bottom-Up Time Construction as a Unifying Physics Theme

Presented by: Terry Bollinger (Apabistia Press)

Presented at: **Ontology Summit 2025, Track 4 (Convener: Dr. Ravi Sharma)**

May 7, 2025

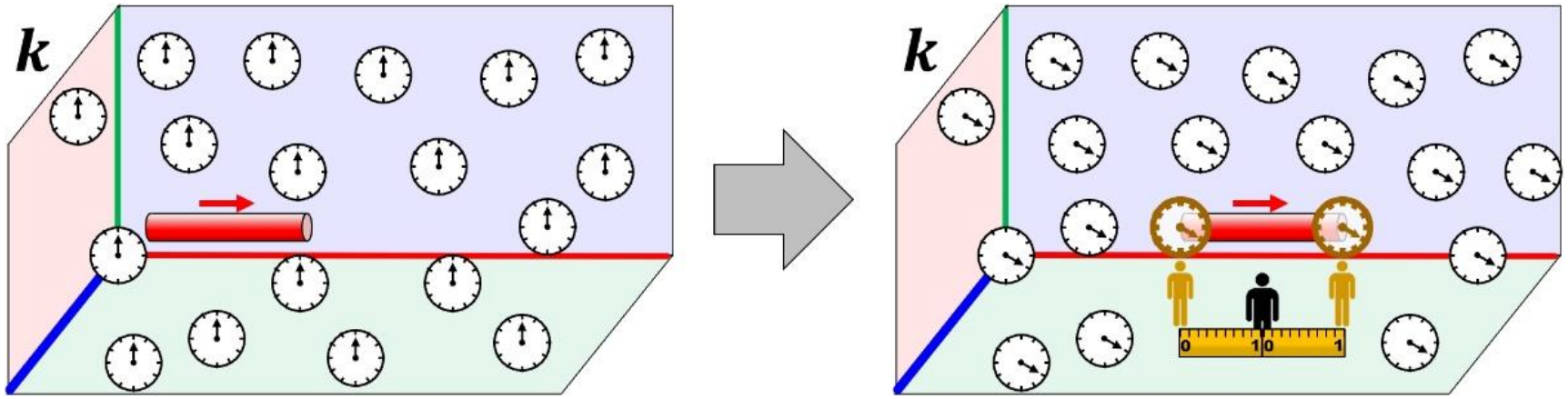
Goals of this Talk

- Argue for more *data-driven realism* in fundamental physics
- Point out the sloppy math in *Minkowski's four-dimensionalism*
- Show why *continuum math* is a profound epistemic error
- Explain the *sparse universe* viewpoint (mass = information)
- Distinguish between physics *persistent* bits and *chaos* bits
- Advocate *quantum-property continuants* to replace particles
- Advocate a new math of *bottom-up space and time* creation

A Tale of Two Einsteins: v1, Intransigent Realist

*"We imagine further that at the two **ends A and B** of the [measuring] **rod**, clocks are placed which **synchronize** with the clocks of the **stationary system**, that is to say, that their indications correspond at any instant to the 'time of the stationary system' at the places where they happen to be. These **clocks** are therefore **synchronous** in the stationary system."*

A. Einstein, *On the Electrodynamics of Moving Bodies*, Annalen der Physik **322** (10), 891–921 [Jun.] (1905). http://fisica.ufpr.br/mossanek/etc/specialrelativity.pdf



A. Einstein, *The Theory of Relativity* [with Figures], Naturforschende Gesellschaft, Zürich, Vierteljahresschrift **56**, 1–14 [Jan. 16] (1911). https://sarxiv.org/ref.1911-01-16.figs.pdf

Einstein v1 on Minkowski's "World Lines" Relativity

Einstein was *not* happy and *not* afraid to say so.

> *"When, later on, Minkowski built up the special theory of relativity into his 'world-geometry,' Einstein said on one occasion: 'Since the mathematicians have invaded the theory of relativity, I do not understand it myself any more.' "*

— A. Sommerfeld, *To Albert Einstein's Seventieth Birthday*, in 'Albert Einstein: Philosopher, Scientist,' P. A. Schilpp, Ed., in 'The Library of Living Philosophers,' Volume VII, Open Court, 1949, pp. 97–106. Page 102.

> *Valentine Bergmann on what Einstein told him about the tensor model: "Superfluous learnedness"*

— A. Pais, *Subtle is the Lord: The science and the life of Albert Einstein*, Oxford University Press, 1982. Page 152.

> Minkowski: *"With a hardy piece of chalk I can draw four world axes on the blackboard."*

— H. Minkowski, *Space and Time.* 80th Assembly of German Natural Scientists and Physicians, Sep 21, 1908.

> Einstein, in a lecture about special relativity shortly after Minkowski's talk: *"This has been done elegantly by Minkowski; but chalk is cheaper than grey matter, and we will do it as it comes."* [Ouch!]

— George Pólya attended the lecture and reported the comment. Béla Bollobás reported Pólya comment in his *Littlewood's Miscellany*, Cambridge University Press, 1986. Page 152 (yes, same page number as the Pais quote).

Minkowski's Justification for "World Lines"

> *"With a hardy piece of chalk I can draw **four world axes** on the blackboard... To **never let a yawning emptiness**, let us **imagine** that everywhere and at any time something perceivable exists. In order not to say matter or electricity I will use the word **substance** for that thing."*

— H. Minkowski, *Space and Time.* 80th Assembly of German Natural Scientists and Physicians, Sep 21, 1908.

➢ That's it: Zero physics, experimental findings, or realism

- Minkowski had an epistemic revulsion to emptiness, at least for time
- Food for thought: Why didn't he also extend particles in x, y, and z? Why were *those* instances of "yawning emptiness" perfectly okay for him?

➢ A deeper secret: This is Calvinist Eternalism in disguise

- Minkowski's closest math friend, Dave Hilbert, was educated in the Calvinist theology of John Calvin, Ulrich Zwingli, and Heinrich Bullinger

There's a Physics Problem with "World Lines"

> *"With a hardy piece of chalk I can draw **four world axes** on the blackboard... To **never let a yawning emptiness**, let us **imagine** that everywhere and at any time something perceivable exists. In order not to say matter or electricity I will use the word **substance** for that thing."*

— H. Minkowski, *Space and Time.* 80th Assembly of German Natural Scientists and Physicians, Sep 21, 1908.

- **Q:** If you extend a particle infinitely in x, y, or z (or any combo), how large does the total mass of this "substance" become? **A:** Infinite
- **Q:** If you instead extend a particle infinitely in time, how large does its mass become? **A:** Infinite, again
- Minkowski (*not* a physicist) never worried about how the intersection of his infinite-mass object with "laboratory now" becomes a finite-mass particle
- Relativity (foliation, gravity) and quantum theory (time uncertainty) make it extraordinarily difficult (impossible?) to recover a finite mass (So: Ignore it?)

Einstein after 1911: v2, Mathematical Mystic

"In Minkowski's [extremely interesting mathematical treatment], we represent physical events in a 4-dimensional space, and the space-time relationships of the results of events appear as geometric sequences in this 4-dimensional space."

A. Einstein, *The Theory of Relativity* [with Figures], Naturforschende Gesellschaft, Zürich, Vierteljahresschrift **56**, 1–14 [Jan. 16] (1911).

"Now before the advent of the theory of relativity it had always tacitly been assumed in physics that the statement of time had an absolute significance [but]… this assumption is incompatible with the most natural definition of ***simultaneity****; if we discard this assumption [of absolute time], then the conflict … disappears."*

[Note: By 1920, Einstein had **fully abandoned the idea that clock time is real**.]

A. Einstein, *Relativity: The Special and the General Theory*. Methuen, 1920.

Einstein, Minkowski, and Survivor's Guilt

A fuller Einstein quote at the threshold (1911) of his transition:

> *"Finally, I would like to say a few words about the extremely interesting mathematical treatment that the mathematician Minkowski gave [my] theory. Minkowski, who died far too young… In Minkowski's approach, we represent physical events in a 4-dimensional space, and the space-time relationships of the results of events appear as geometric sequences in this 4-dimensional space."*

A. Einstein, *The Theory of Relativity* [with Figures], Naturforschende Gesellschaft, Zürich, Vierteljahresschrift **56**, 1–14 [Jan. 16] (1911). p. 14

- Most discussions of Einstein's conversion focus solely on his need for a more powerful mathematical curved-space (tensor) framework
- An overlooked factor: *Survivor's guilt*. Einstein had openly and sarcastically blasted Minkowski's "chalk for brains" ideas shortly before his tragic death

Why Did Einstein Abandon Clocks?

- **Three factors:**
  - Gravity forced him into *curved space* thinking, requiring tensors (**vital!**)
  - After Minkowski's tragic death, Einstein felt awful about ridiculing him
  - Far more subtly: Einstein had a secret worry about his Realist relativity

> *(1) This conclusion [that my 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*' (Sec. 3), pp. 418–420, in '*About the Principle of Relativity and the Conclusions Drawn from It*,' pp. 411–462, in '*Jahrbuch der Radioaktivität und Elektronik*' 4 (4), 418–420 (1907).

- **A dirty little secret:** Einstein could not get his equations to predict what would happen *in his own thought experiments*

Three Errors That Undercut Einstein's Realism

(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"

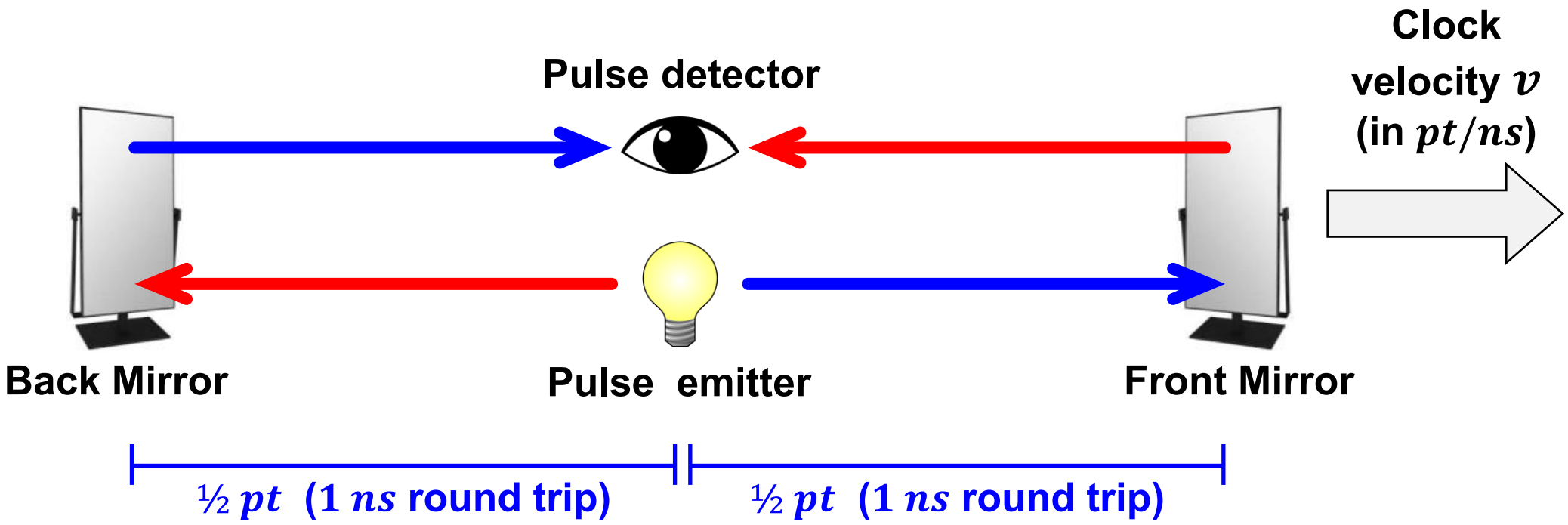
— A. Einstein, 1911. Page 8 of *The Theory of Relativity*.

The Critical Issue of Simultaneity

- Einstein made the **non-simultaneous events** issue famous with his lighting-and-train thought problem.
- Yet, strangely, he never wrote down an equation for calculating the degree of non-simultaneity precisely. Why?
- Up until 1911, Einstein stuck clocks *everywhere*… except on his own non-simultaneous thought experiment trains!
- **Question:** Why didn't Einstein add clocks to his trains? He had the math! It's built into his transformation equations.
- **Answer:** No matter how hard he tried, he could not prevent causality paradoxes from arising. Minkowski gave him a out!
- *Light clock-rulers* provide a mechanism to examine this issue.

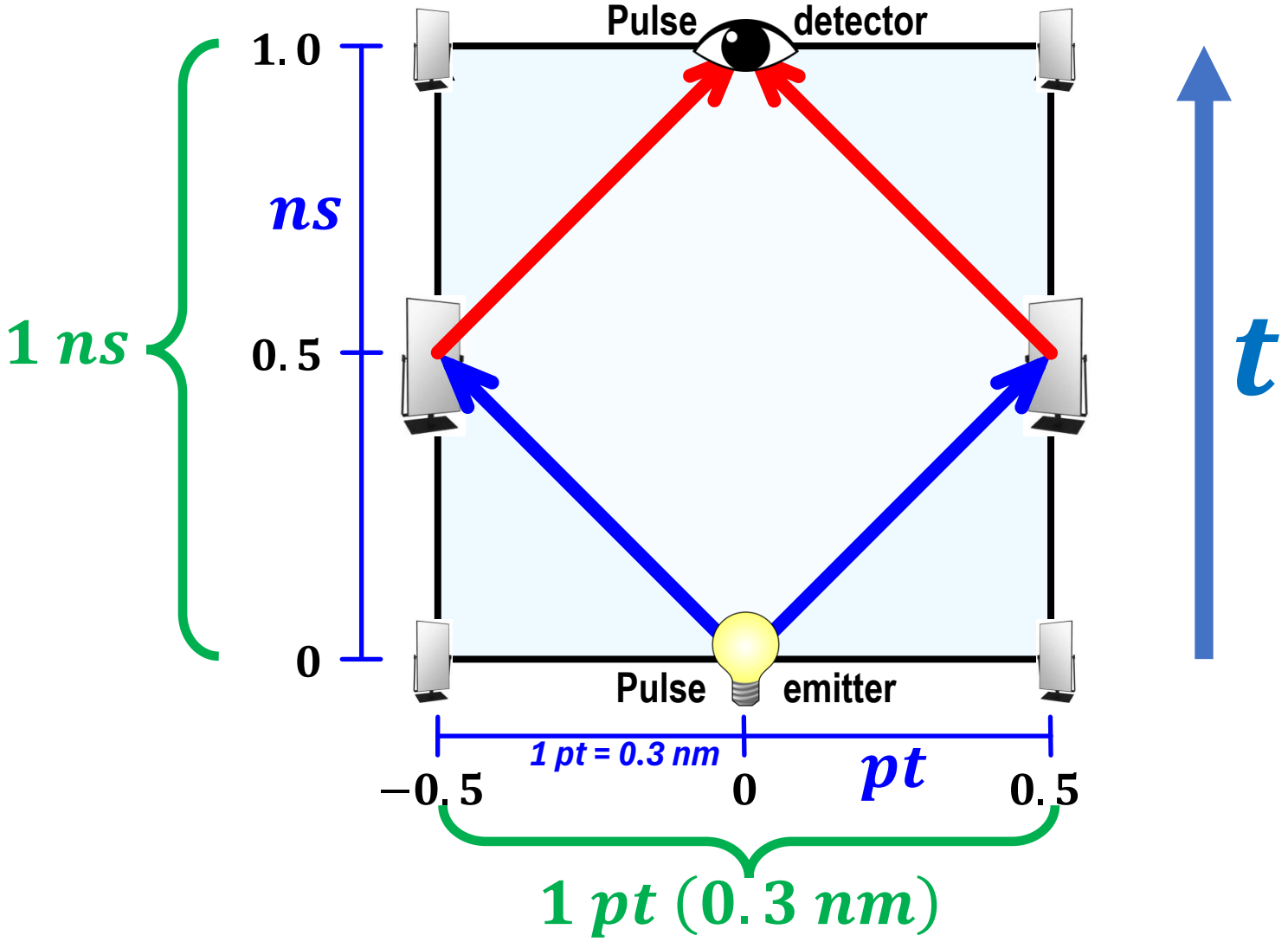
Javelin Clocks: Movable Light-Based Clock-Rulers

This clock measures 1 ns and 1 pt per cycle

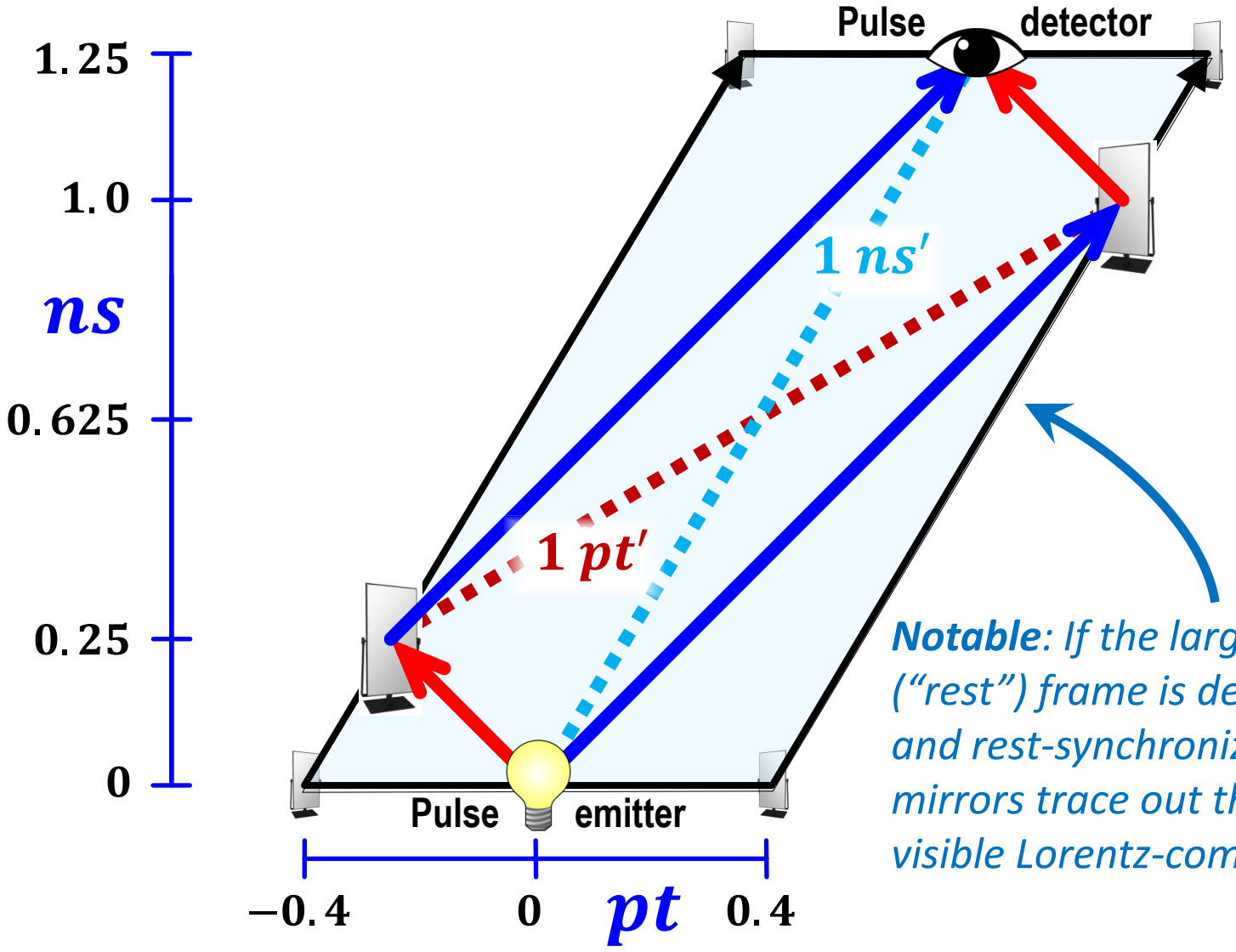


1 pt = 1 photon foot = 1 light-ns = 0.983571 foot = 0.2998 m ≅ 0.3 m

One Javelin Clock-Ruler Cycle



One Javelin Clock-Ruler Cycle at $0.6\ c$



***Notable**: If the larger, unaccelerated ("rest") frame is dense with detectors and rest-synchronized clocks, the mirrors trace out this experimentally visible Lorentz-compressed trapezoid.*

Clock-Ruler Trapezoids in Minkowski's 1908 Spacetime Figure

$$c^2t^2 - x^2 - y^2 - z^2 = 1.$$

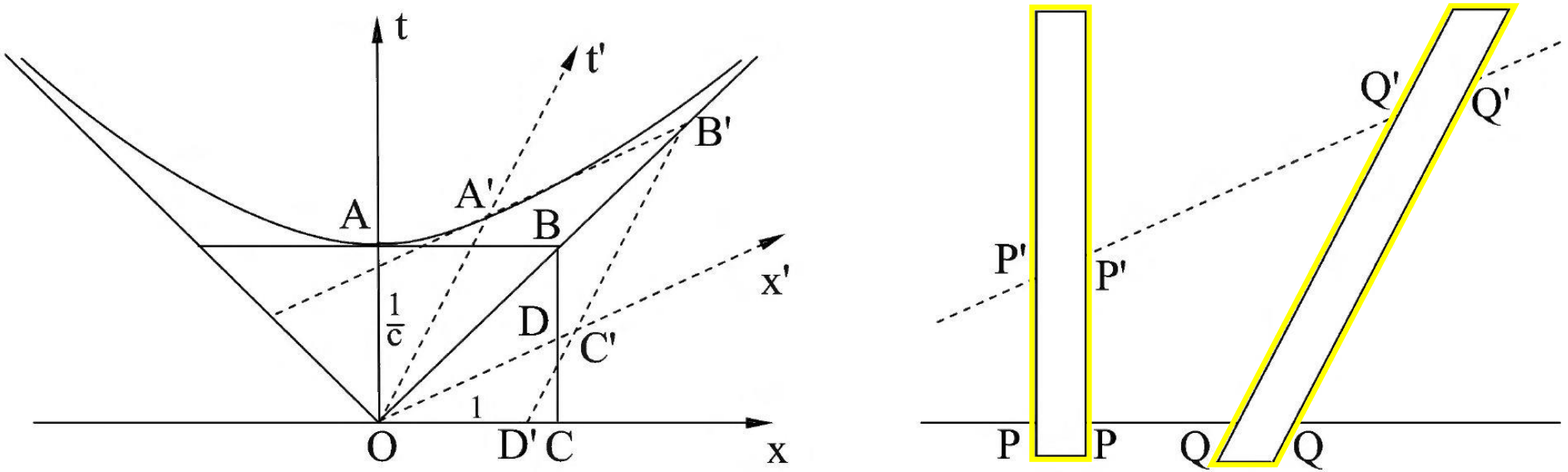
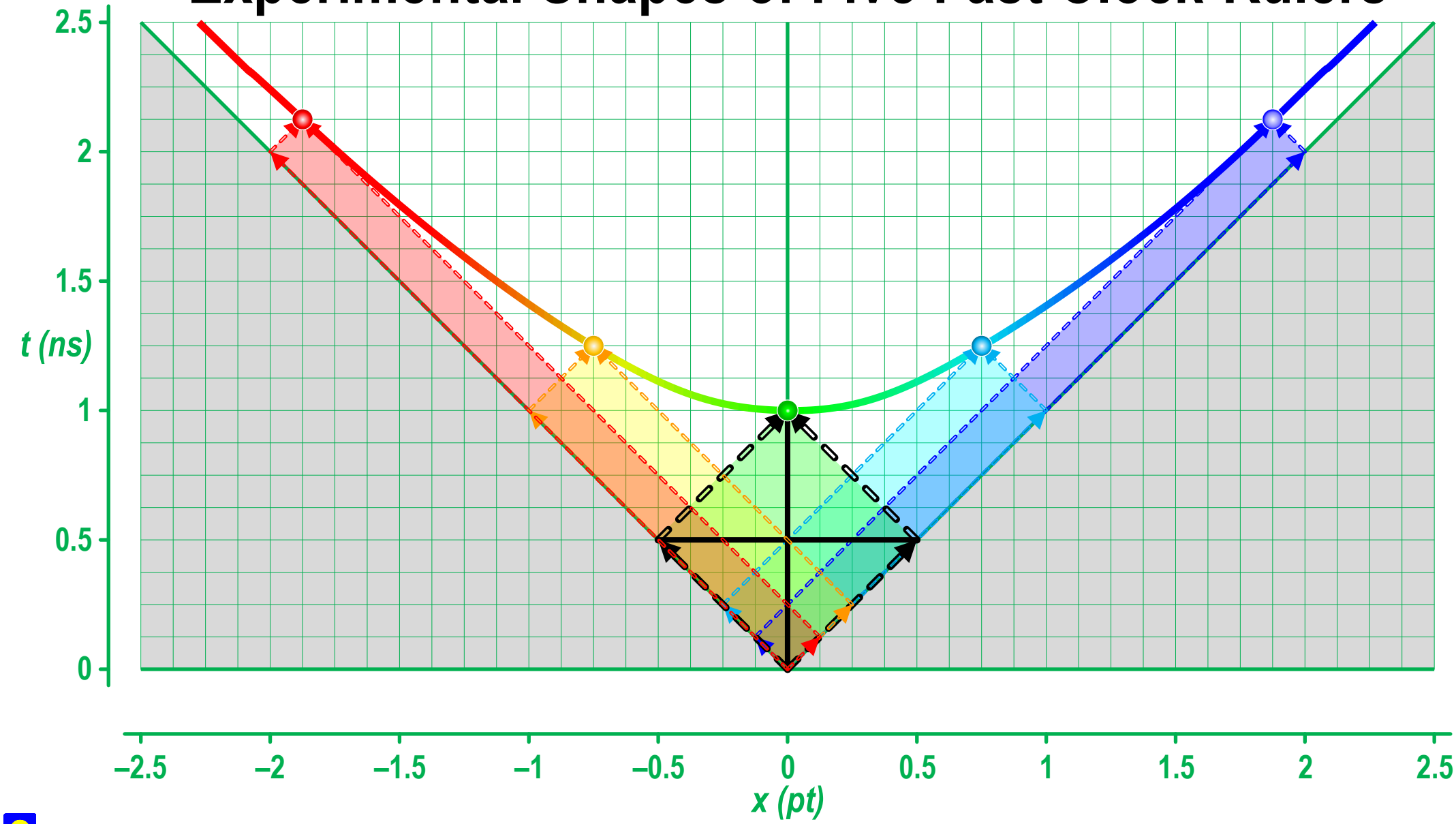


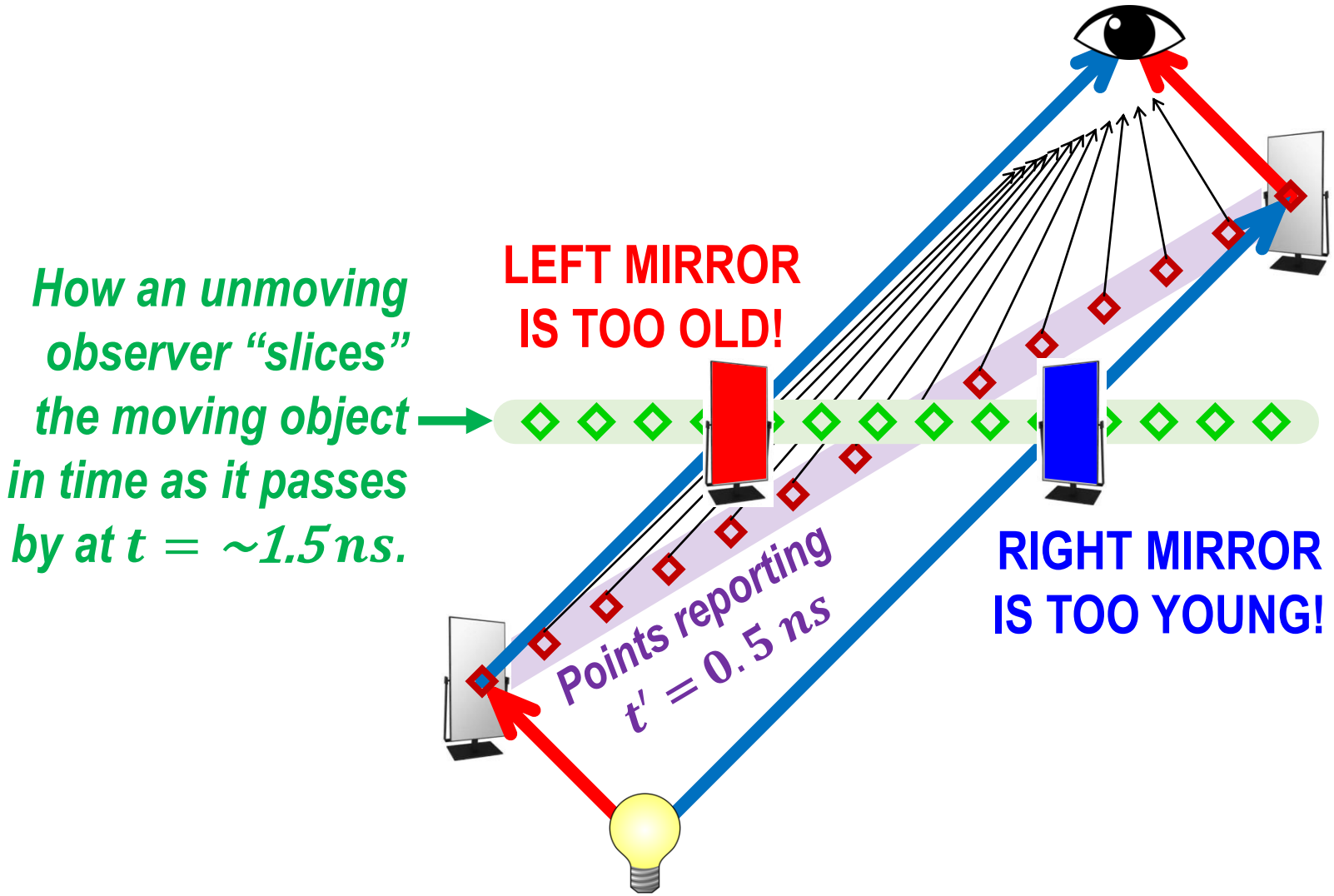
Fig. 1

H. Minkowski, *Space and Time*, 80th Assembly of German Natural Scientists and Physicians (1908).

Experimental Shapes of Five Fast Clock-Rulers



Moving Objects are *Internally Asynchronous*



Einstein's Cross-Frame Synchronization Dilemma

- **Einstein *knew* objects (trains) were internally asynchronous**
  - He's the one who *figured this out* in his non-simultaneous fast trains
  - He figured it out (e.g., 1911) by putting synchronized clocks everywhere
  - He used this knowledge to correctly predict the Twins Paradox (1911)
- **The problem**
  - His equations gave no obvious way to synchronize *across* frames
  - Each moving frame had its definition of time… but how did they "touch"?
- **Enter Minkowski…**
  - Minkowski was interested only in the *symmetries* between the frames
  - His clever "mixed signature" Minkowski space trick eliminated the synch problem by *hiding it* beneath symmetrical (Einstein) equation set

A Small Omission with Broad Implications

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

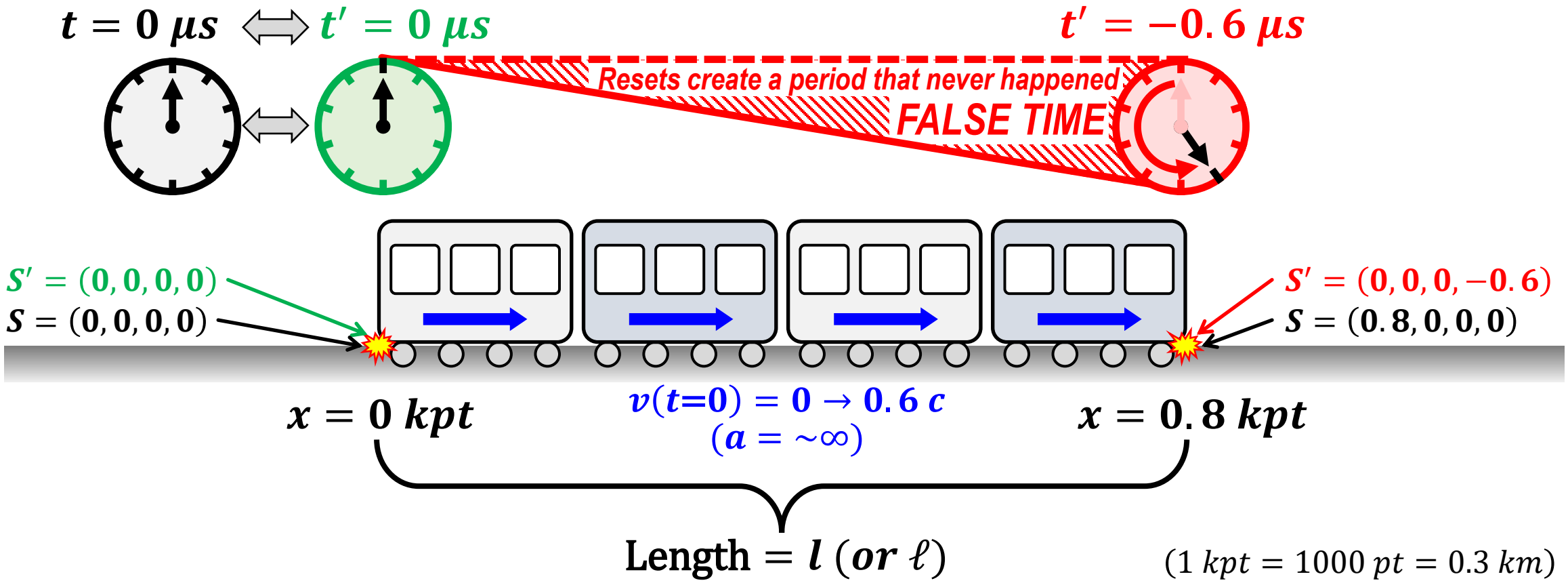
$$t' = \gamma\left(t - \frac{v}{c^2}(x)\right)$$

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

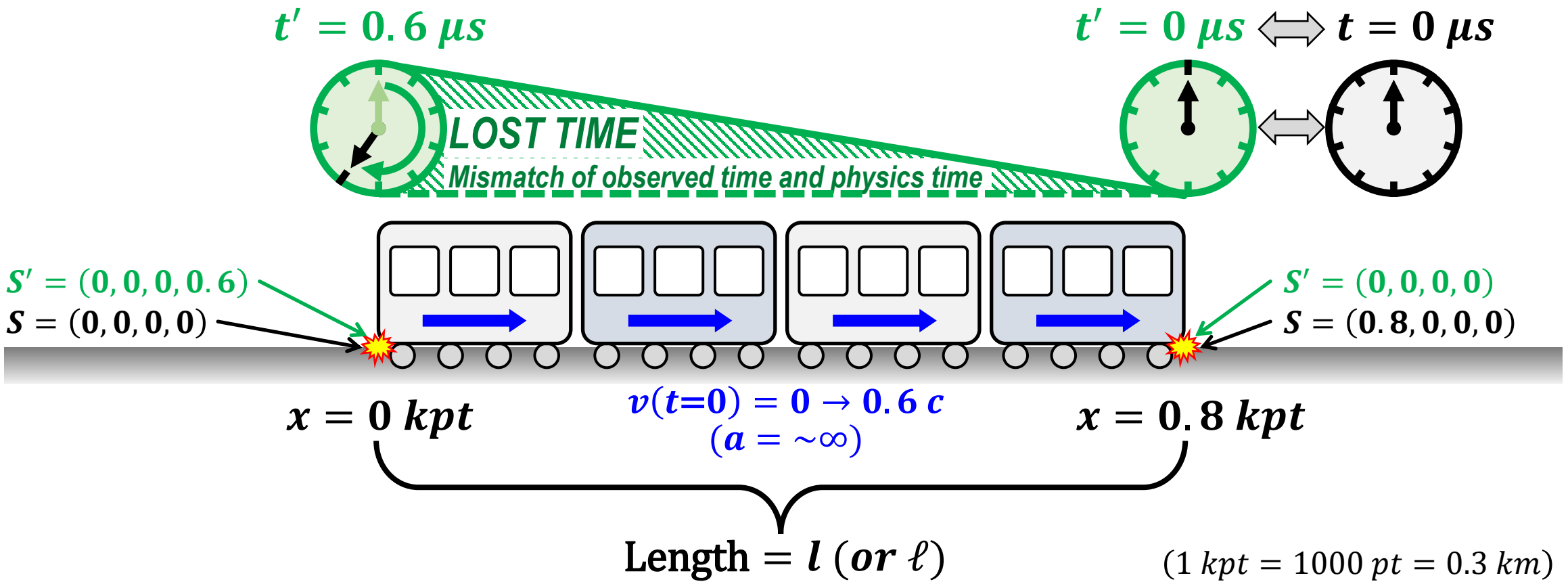
$$t' = \gamma\left(t - \frac{v}{c^2}(x - l)\right)$$

We don't notice because the *point approximation* (pretending moving objects are "mostly" point-like) works very well for most situations.

The Paradox: $t' = 0$ at $x = 0$ (Einstein's Collocation of Origins)



The Resolution: $t' = 0$ at $x = 0.8$ (Keep t' Positive)



Einstein's False-Time Dilemma

- **Einstein likely knew his equations created false time**
  - His footnote worrying about physical transformation is a clue
  - The "tell" is his avoidance of putting on moving trains
  - Had he done so, he would not have been able to give precise answers
- **The Calvin (not via Hobbes, via Hilbert) temptation**
  - The easy out: Assume that *false time* is always *real time*… somehow.
  - This is predestination: The idea that "the fix" on time is already in.
- **The Minkowski temptation**
  - Minkowski took Einstein's error and made it *beautiful* and *geometric*
  - Once Einstein realize that Minkowski space *required* a block universe that solved his false time problem… well, the rest is history

Determinism (= Predestination) is Not Science

➢ Determinism is not Realism

- Worldlines are, by definition, epistemic and untestable

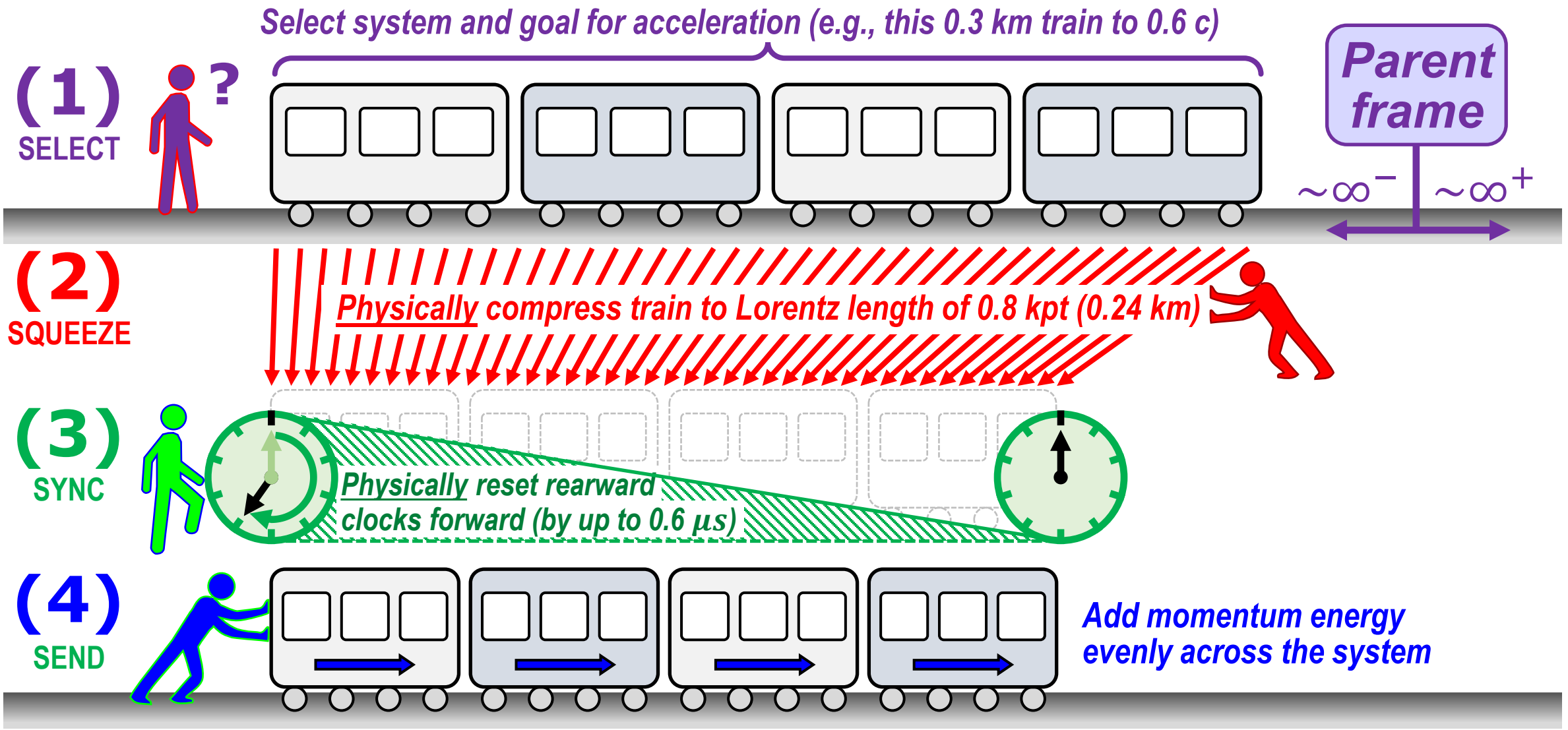
➢ Determinism is not Science

- Worldlines are *nominally* testable, but are instead treated as epistemic
- Any answer that says “it depends on your view” is *not* using experiments
- Minkowski simply did not care about experiments, only symmetry

➢ Can light clock-rulers make relativity testable again?

- Yes, definitely. But first you have to chuck Minkowski space out the window *except* for special narrow cases (e.g., *inside* spaceships, only)
- 4-Euclidean “launch perspective” *trapezoidal space* replaces Minkowski space — the space that Minkowski *almost* began exploring in his figures!

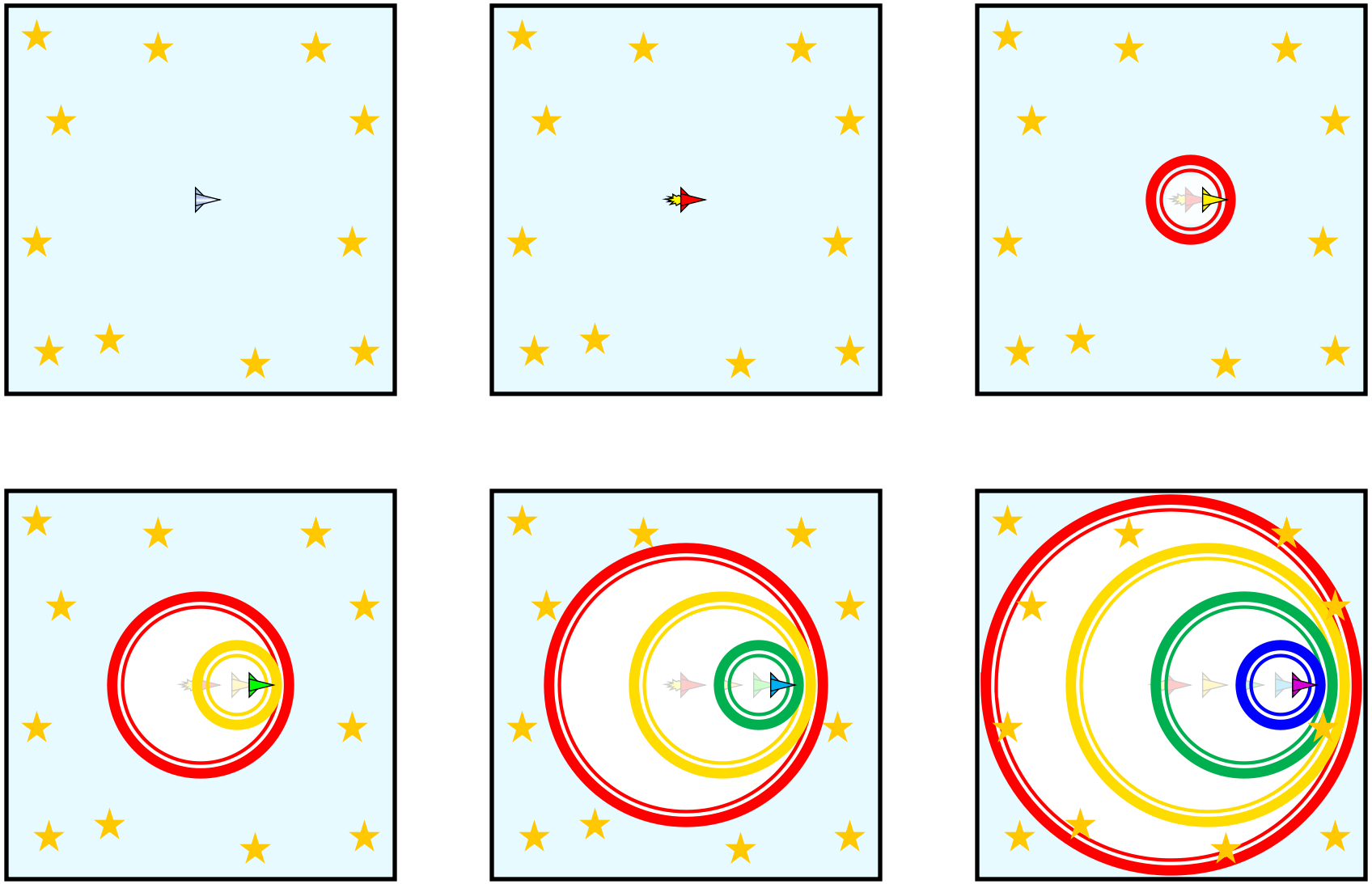
Four Steps in Creating a Metrics-Capable Spacetime Instance



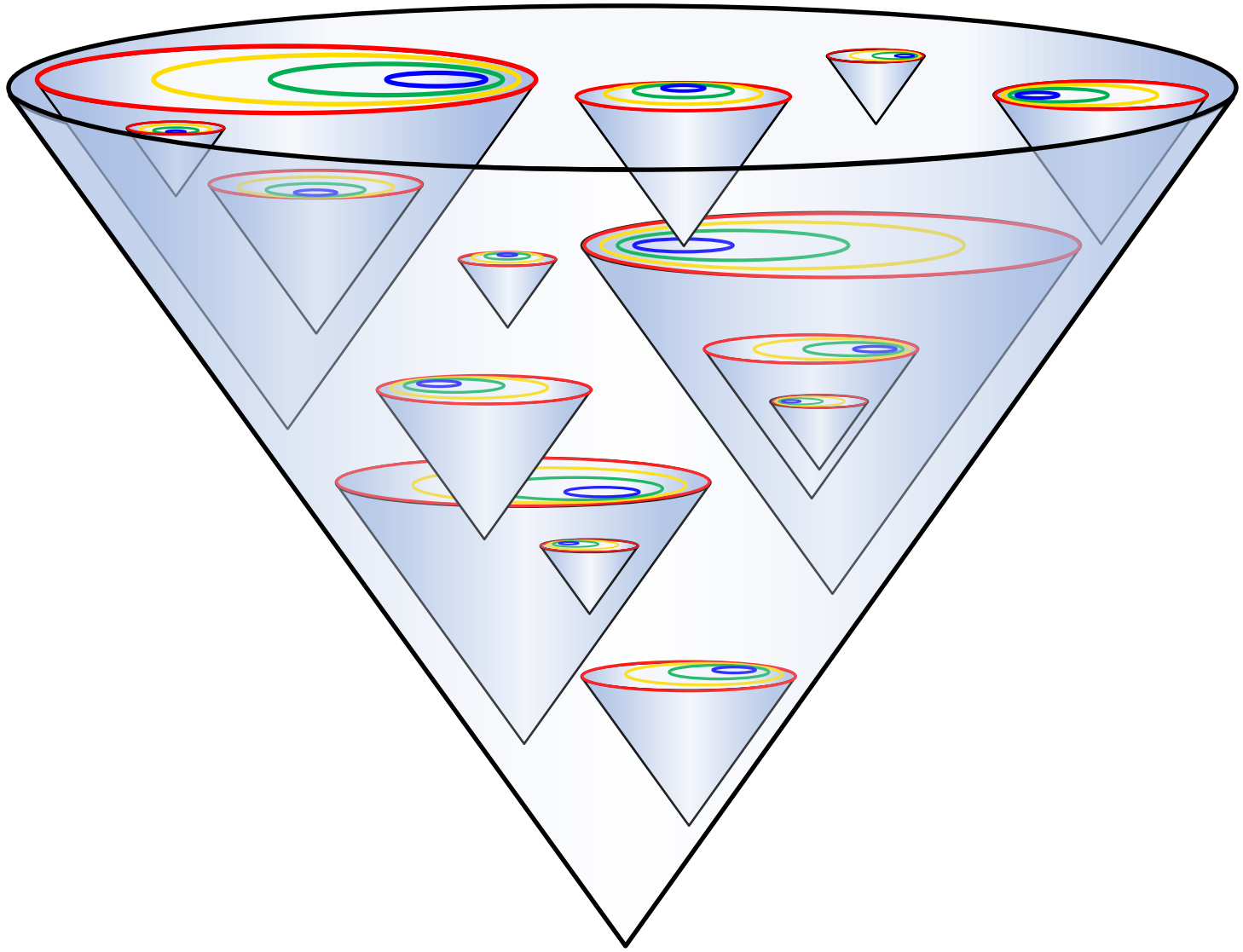
Acceleration Is Complicated

- Einstein co-located the origins of two inertial frames.
- Applying origin co-location when creating (accelerating) a Child frame from a Parent *necessarily* creates “false stories”.
- Even worse, every such Child origination (acceleration) brings two fundamental definitions of time into direct conflict:
  - *Experienced time* is time witnessed continually by an observer, even if it passes at differing rates.
  - *Physics time* is the time required to replicate the full range of physics, from particle physics up.
  - Ironically, it is the *physics time* that can never be restored immediately after an acceleration (!)

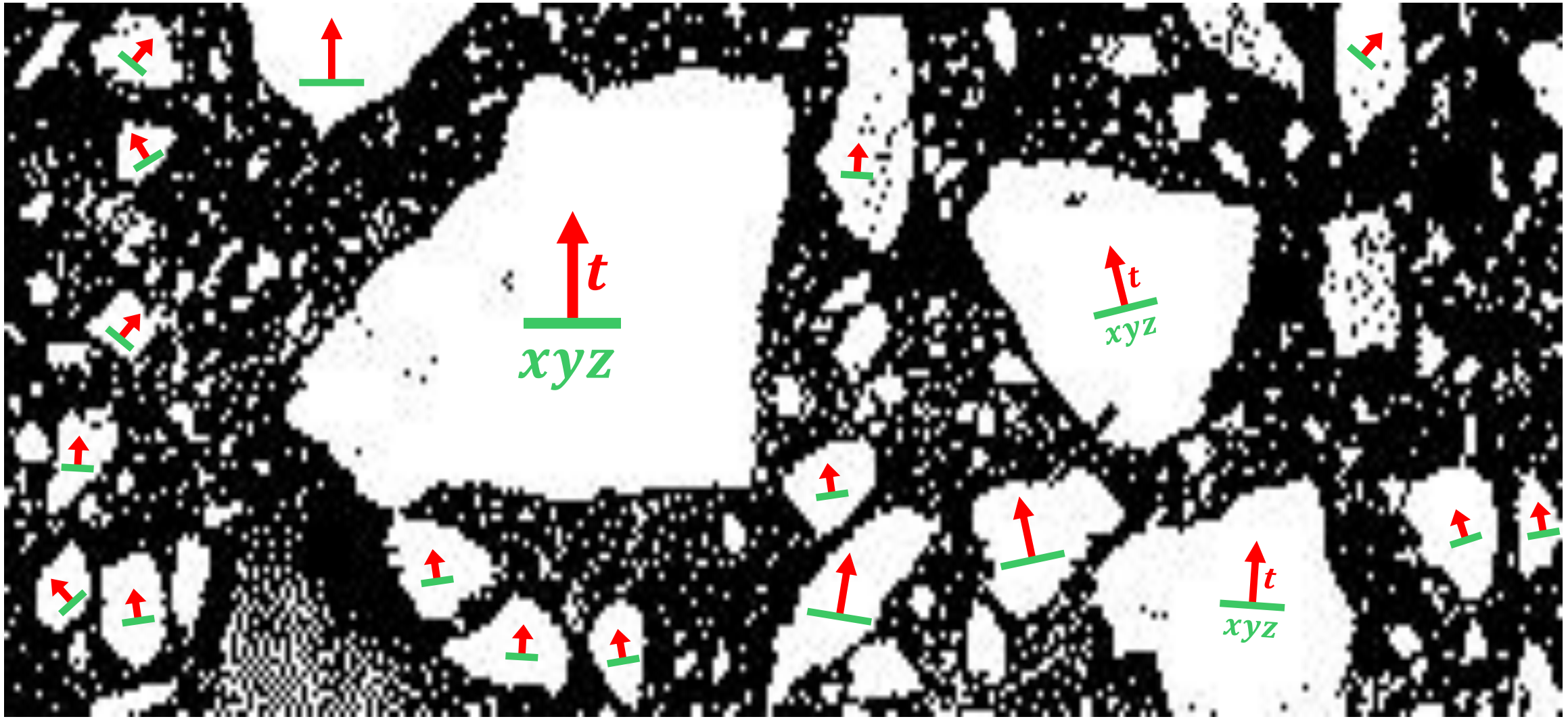
Attaching Relativity Frames to Material Objects



Cones Within Cones: Fractal, Matter-Centered Spacetime



The Brecciated Universe: Competing Spacetimes



Bringing in the Sparse Interpretation

- A *sparse interpretation* interprets subatomic mathematical complexity as mostly *chaos bits*. A smaller set of *persistent bits,* associated solely with matter, generates the chaos bits.
- The idea that accelerated systems *create* unique instances of spacetime is trivially consistent with a sparse interpretation.
- Combining the sparse interpretation with bottom-up, particles-first spacetime creation suggests a radical view:
  - Most of quantum physics emerges from *incomplete* early stages in the emergence of “classical” spacetime.
  - This view pushes the Standard Model to the top of physics.

Classical Reality as Emergent Data

> *"Data are fragments of a theory of the real world, and data processing juggles representations of these fragments of theory..."*
> *— George H. Mealy (1967)*

- Local emergence of orthogonal space and time *enables* data
- A good data model is more than an analogy; it captures reality
- Reality and model differ in the use of deep physics continuants
- Similarly, good data processing shares methods with reality
- Data processing does more than juggle; it *creates* continuance

Continuum Math as Classical Physics in Disguise

- Any concept of geometric stiffness and angles requires familiarity with fermionic condensed matter physics.
- This idea is so critical to survival that it is wired into our brains.
- Real fermionic matter has *finite* (atomic or particle) bit density.
- From quantum physics, we now know classical (geometric) optics is an illusion that assumes point-like, bullet-like photons.
- Continuum math creates bogus (chaotic) information densities, e.g., at the $|0\rangle$ top of a nominally symmetric Bloch sphere.
- Bottom line: Assuming infinite free resolution creates noise.

Einstein's Other Epistemic Error: The Photon

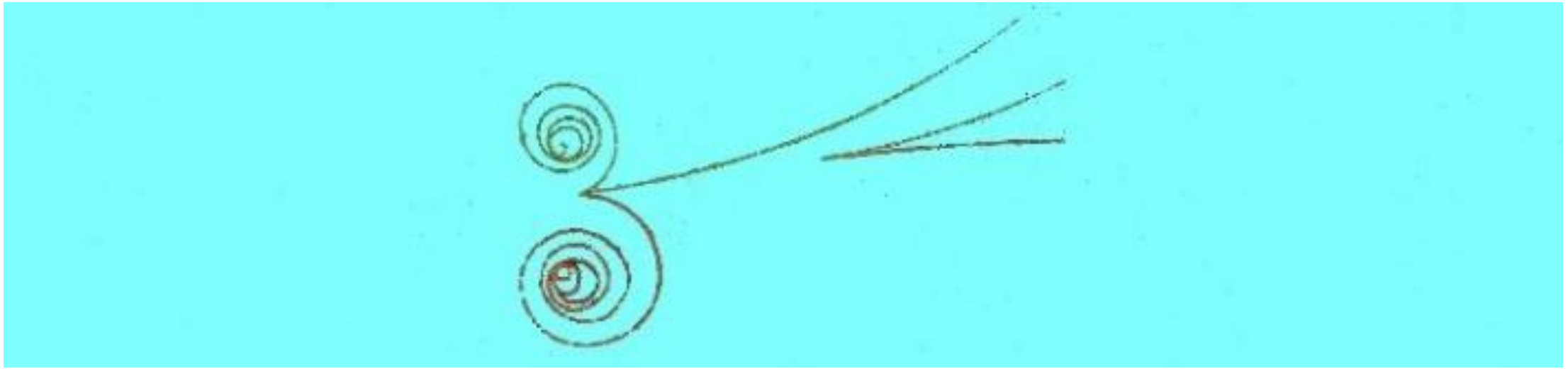
> *"According to this picture [of quantized emission and absorption of light], the energy of a light wave emitted from a point source is not spread continuously over ever larger volumes, but consists of a finite number of energy quanta that are spatially localized at points of space, move without dividing, and are absorbed or generated only as a whole."*

— A. Einstein, *On a Heuristic Point of View about the Creation and Conversion of Light*, *Annalen der Physik* **17** (1905). p. 133

- **This is an extremely reasonable classical deduction**
  - The behavior of particles in cloud chambers seems to support this
  - Our survival-oriented neural circuitry insists this must be correct
- **The problem:**
  - *Between* emission and absorption, *all* particles (including even some large molecules) reflect and diffract *only* like waves. Very odd!

The Particle Path Illusion

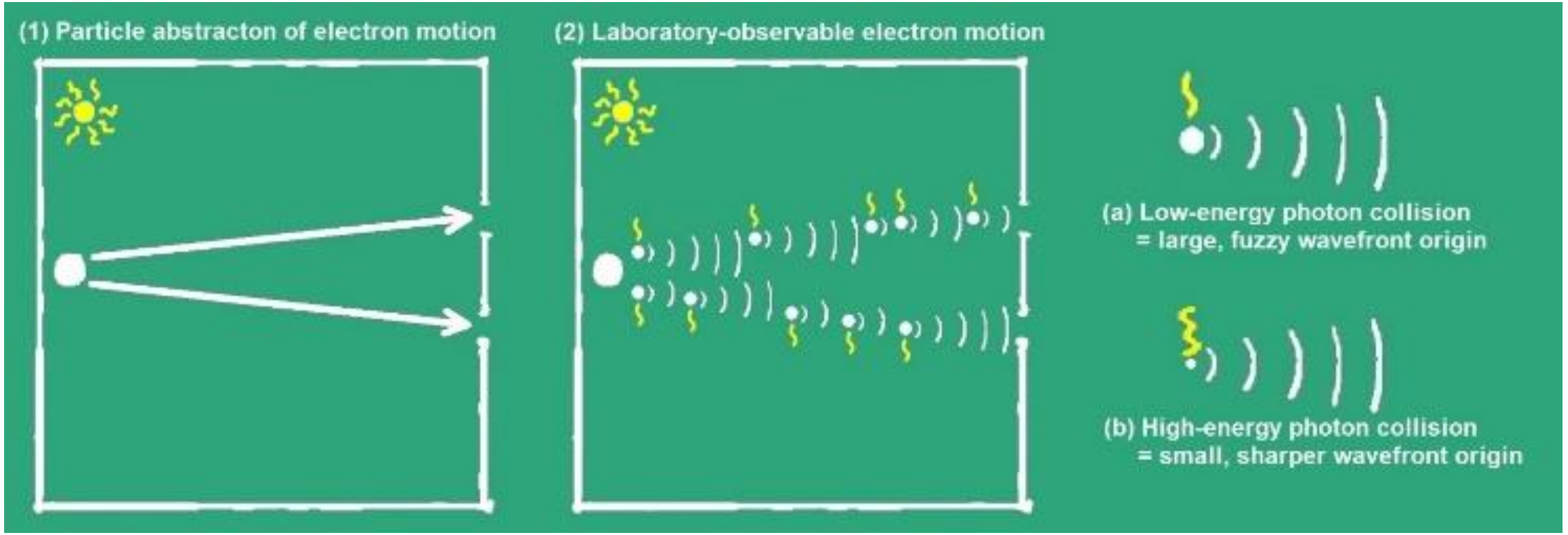
- Nearly everyone has seen images of charge particle traveling through bubble chambers
- These views match perfectly with our classical large-object views
- They are false; particles in dark vacuums *do not* behave this way



The Sadly Mundane Secret of Quantum Collapse

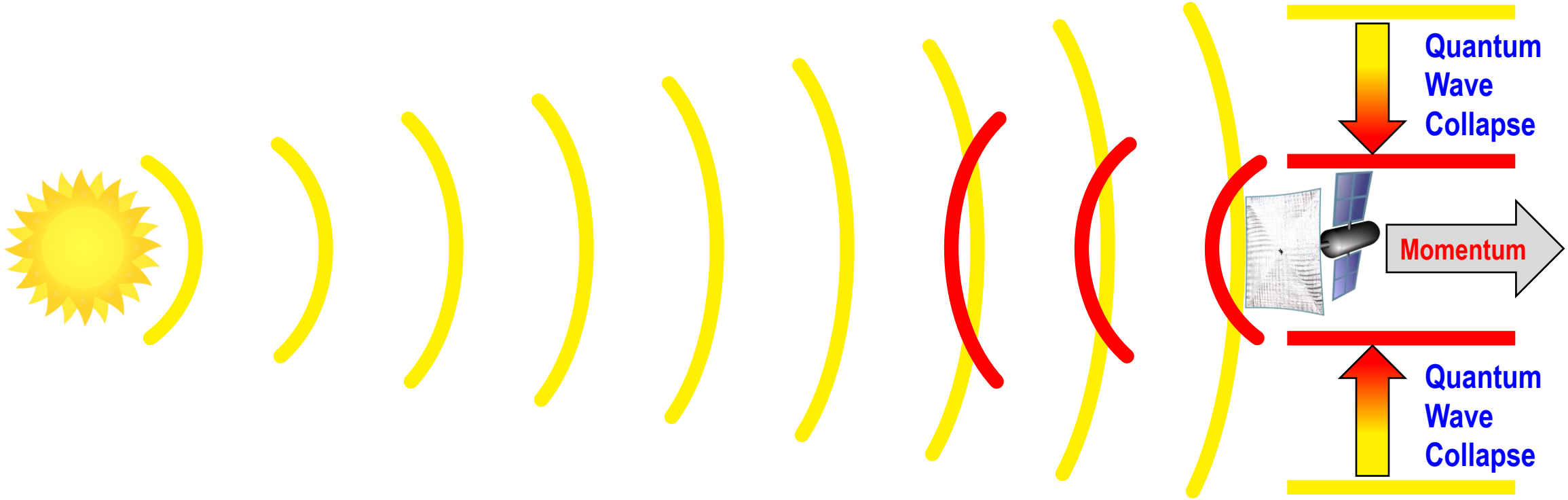
- **It's just bumping**: acceleration, no matter how small
  - The secret is that linear momentum is *not* quantized like energy
  - The only constraint is that the sum of all pushes and shoves *fully cancel*
  - The universe can (and does) constantly create new momentum pairs
  - *Every photon* that reflects creates such a momentum pair
  - This is why "observation" seems independent of physics (but is not)
  - There are no "observers" or "sentient matter"… just *bumping*.
- **Far from being rare, quantum collapse is incredibly common**
  - We focus too much on cases where momentum is *excluded* (e.g., cryo)
  - Bonds also "bump," creating atoms (proton-electron mutual observation)
  - Atomic bumping (thermal noise) and bonds **create** classical reality

The Particle Path Illusion: Photons as Observers



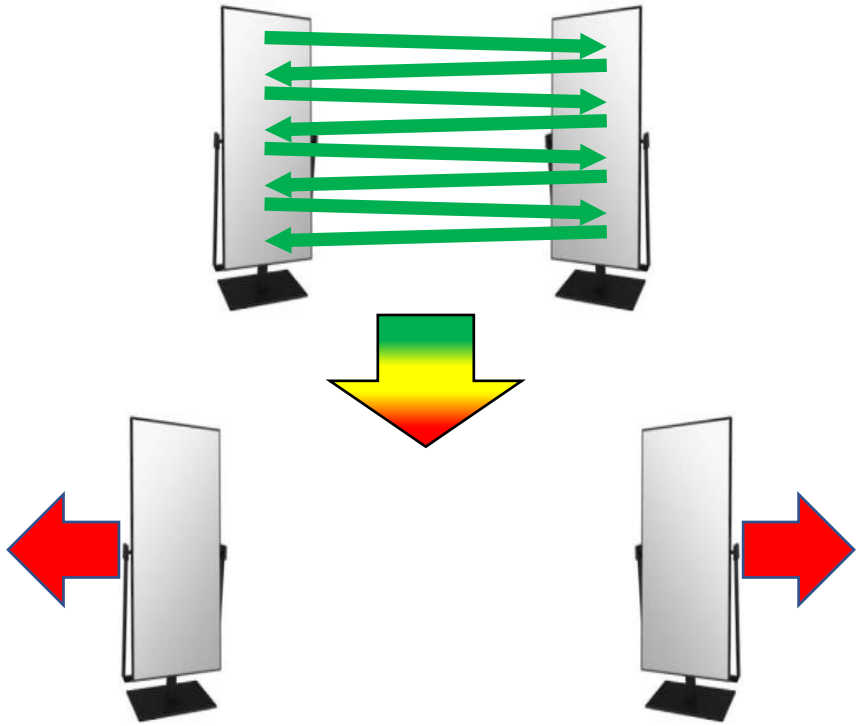
- The ease with which we can use light to do observation fools us into thinking there is no classical "quantum collapse" issue
- The truth is the exact opposite; classical is collapse-intensive

Quantum Wave Collapse at Human Scales



Why Momentum Makes Wave Collapse Look Magical

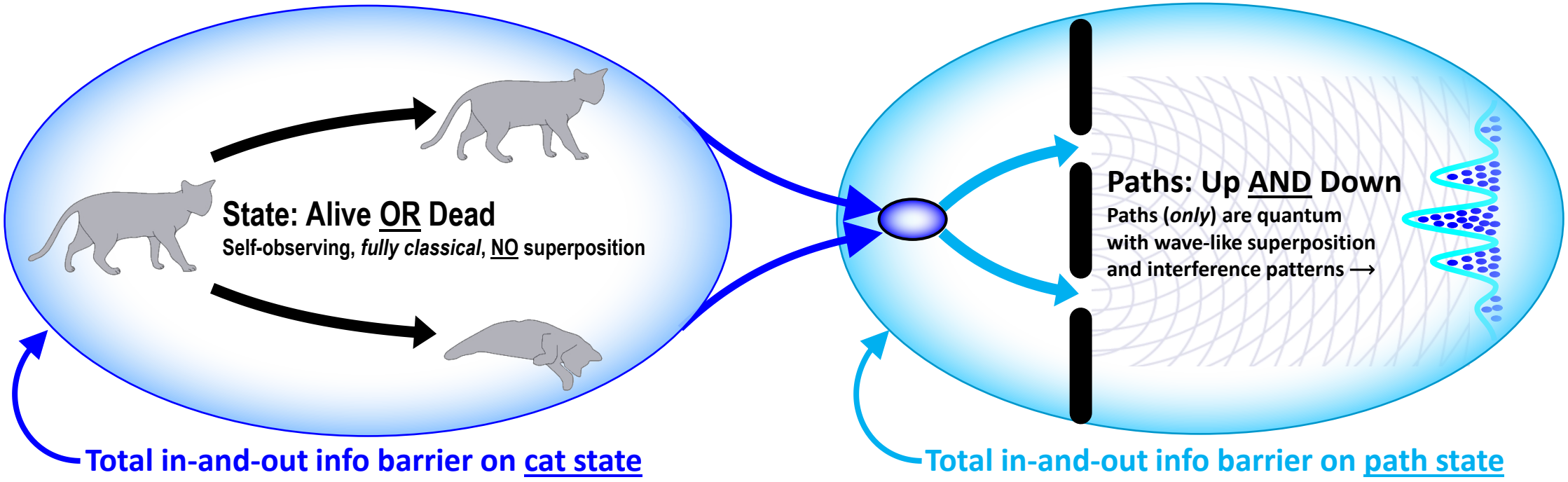
Start: One Green Photon



Finish: Pure Momentum (But *how much?*)

- **Intuition says: *"One green photon cannot create much momentum."***
  - We expect it to be proportional to the incredibly tiny energy of one photon
- ***This is not correct***
  - The momentum potential of one green photon *increases* with mirror mass
  - One photon can nominally create two locomotives of momentum. (!) But…
  - … each mirror must have 58.3 solar masses, and must keep reflecting for 40 million times the universe's age (!)

Quantum Superposition is All About Creating *Spacetime*



Fractal Spacetime Summary

- Spacetime is a set of relationships between entities that are:
  - Persistent (highly conserved, not easily destroyed).
  - Devoid of spacetime shape (*nirakar*, निराकार, Sanskrit for "unformed").
  - *Neither* point-like *nor* wave-like. Points and waves are short-term transient views (chaos bits) created solely by interactions with frames.
  - Capable of mutual exclusion (Pauli exclusion).
  - In large numbers, capable of shaping exclusion into orthogonalities.
  - Capable of stability, that is, of forming new persistent relationships.
  - Capable of change, which can organize into an orthogonal time axis.
- Spacetime is hierarchical with fractal self-symmetry.
- Spacetime does not exist without matter (matter's "address book").

Sparse Universe Summary

- Space and time are secondary relationships generated by matter
- Information is sparse and strictly limited by total mass-energy
- Continuum math is an epistemic illusion of 1700s classical physics
- All limit-free uses of continuum math are epistemic errors
- Conserved quantum numbers, not particles, are continuants
- Particles are sequences of occurrent spacetime processes
- Force attraction (acceleration) defines classical time bottom-up

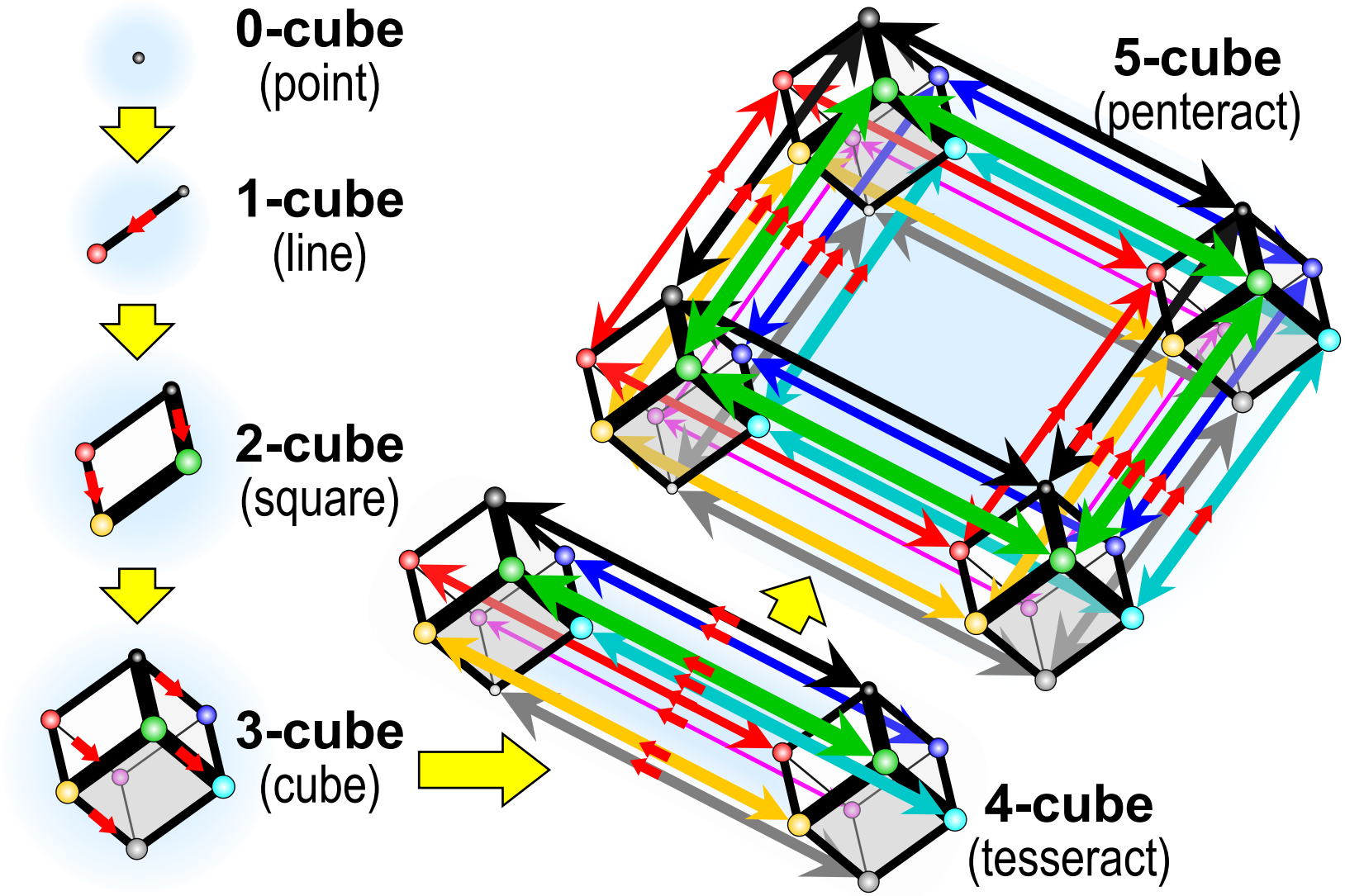
The Smallest Clocks in a Sparse Universe

> *"There are three different ways of specifying the energy: by the **frequency** of an amplitude, by the energy in the classical sense, or by the inertia. They are all equivalent; they are just different ways of saying the same thing."*

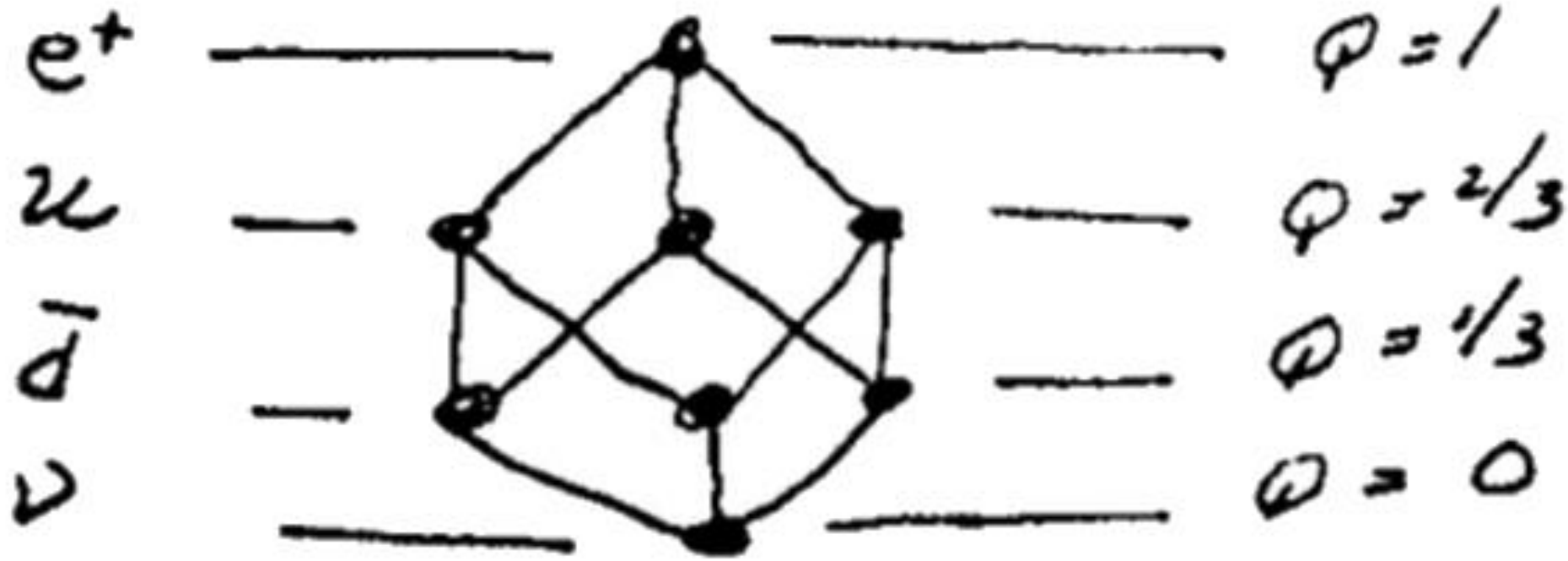
— R. Feynman, *Three ways to define total mass-energy* [Lectures III 7-1 para 8], vol. 3. Caltech, 1963.

- **Clocks are nothing more than recognizable cycles**
  - Angular acceleration defines them; they are *self-observing*
- **The Standard Model fundamental particles are *all* clocks**
  - Spin is their version of angular acceleration and defines their existence
  - Half-spin (fermions) are special: They define the smallest units of time

Simple Sparse Occurrents Create Various Cubes

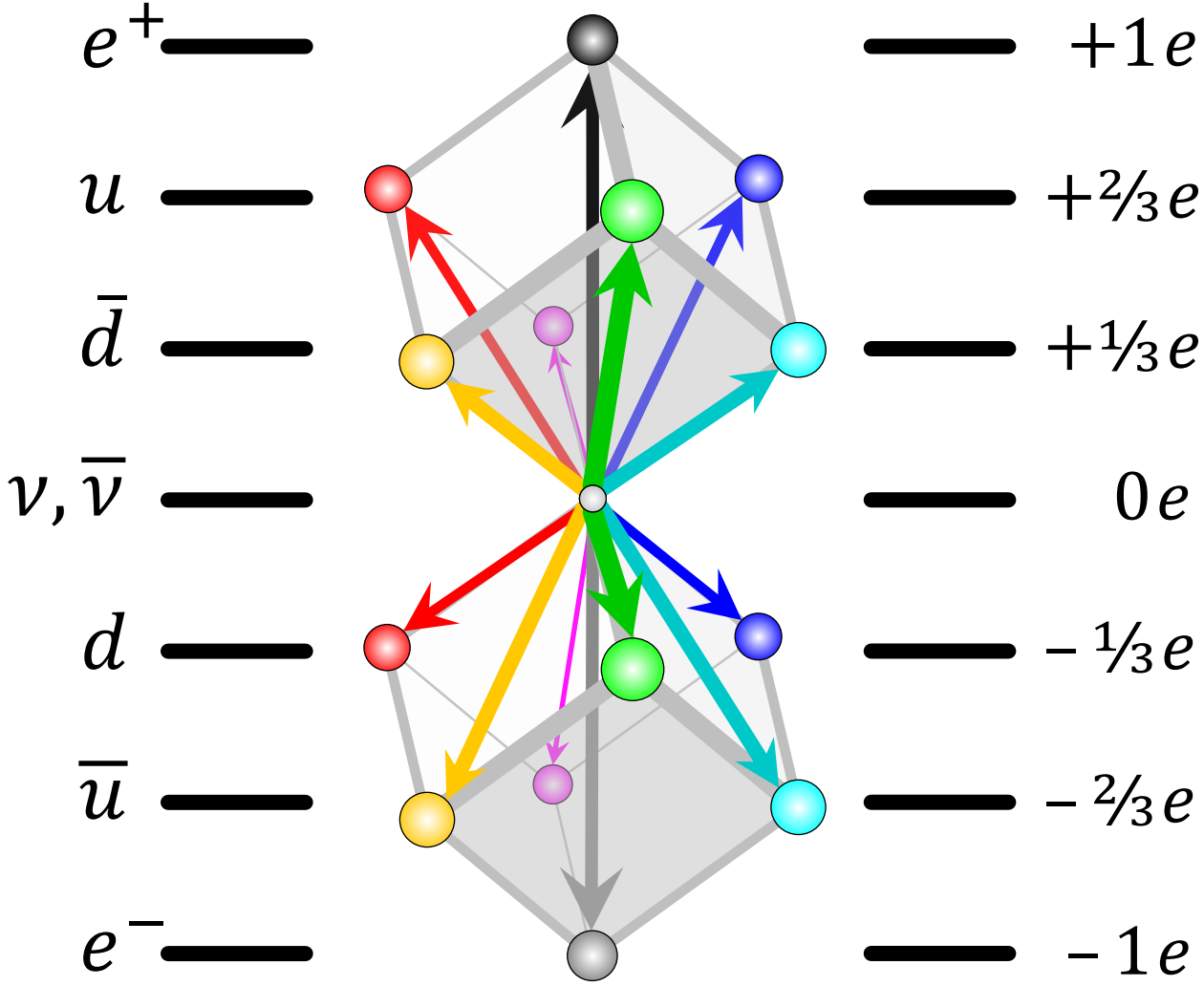


The Glashow Fermion Cube



S. L. Glashow, "The Future of Elementary Particle Physics [HUTP-79/A059],"*Harvard University Preprints*, Jul. 1979. Available: https://inspirehep.net/literature/144466. Page 29, Section III, *Let the Desert Bloom!* S. L. Glashow's original hand drawing.

The Charge-Time Correlation Hypothesis



- Discarding historical boundaries between electric and color charges gives a simpler set of data invariants
- The *charge-time correlation hypothesis* interprets each charge as an attempt to create a time axis
- Only one axis, electric, survives at large scales

A Different Mathematical Path

- Hypothesis #1: The only persistent bits (p-bits) in the universe are those directly associated with matter and energy.
- Hypothesis #2: Physics processes generate non-persistent chaos bits (c-bits) primarily in response to energetic probing.
- Hypothesis #3: The majority of chaos bits describe in papers are not real, but are created on paper by applying impossible classical 1700 math ideas such as infinite free bits, infinite light speed, perfect points, and “free” dimensional orthogonality to domains in which number persistent bits is tiny.
- New goal: Develop the mathematics of *sparse-bit physics*

Summary

- There is danger in math models that are too beautiful!
  - Beauty too often means *oversimplification*
  - Math itself has a deep relationship to classical physics, borrowing many of its "simple" concepts such as metrical space from physics.
  - Example: The Poincaré symmetries work fantastically well, but do *not* tell a sufficiently detailed story of what a "boost" truly means.
- A new path: If particles and fields are nothing more than creations of inertial frame instances, what is hiding deeper?
  - What are the precise rules that govern the deeper, enduring, nirakar entities that disregard spacetime and only pose as particles or waves?
  - What are the rules that *precede* the emergence of space and time?