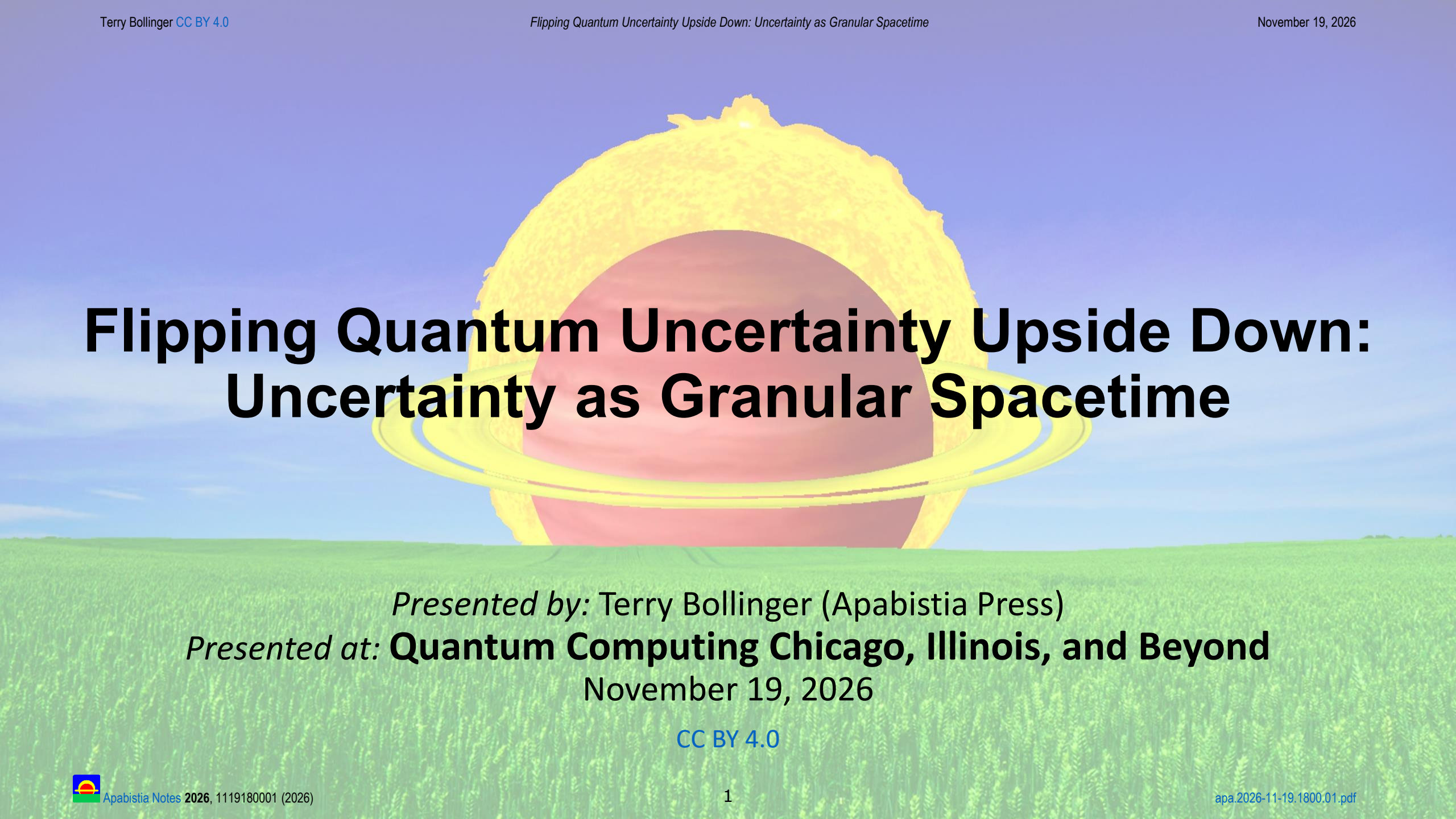


# Flipping Quantum Uncertainty Upside Down: Uncertainty as Granular Spacetime

*Presented by:* Terry Bollinger (Apabistia Press)

*Presented at:* **Quantum Computing Chicago, Illinois, and Beyond**

November 19, 2026

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# Overview

I. The Energy Problem in Quantum Mechanics

II. A Critical Look at Quantum Modeling

III. A Vital Tangent: The Role of Special Relativity

IV. Houston, We Have a Problem

V. The Cayleyverse

VI. The Bumping Problem

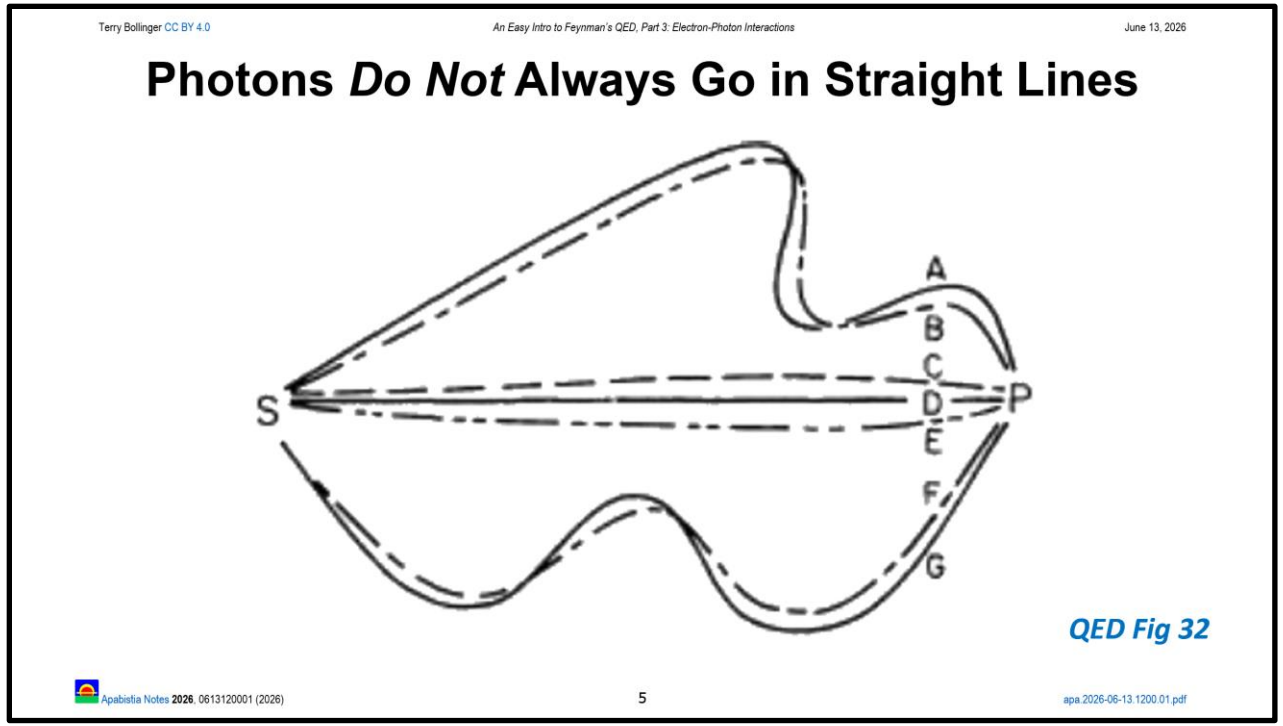
VII. Back to the Quantum Energy Problem

VIII. Summary: Back to Quantum Computing

# Part I.
# The Energy Problem in Quantum Mechanics

# The Quantum Principle of Superposition

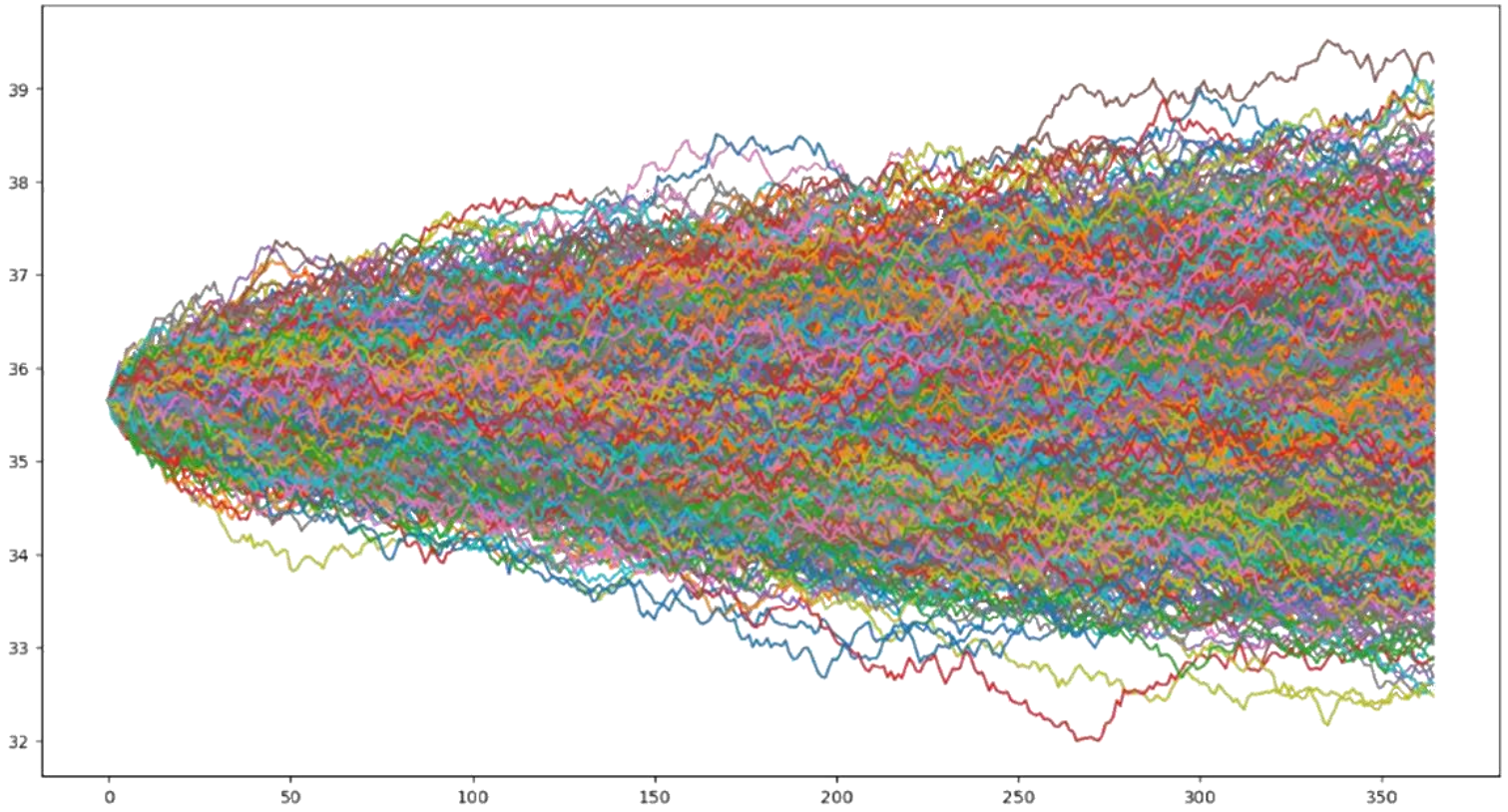
- You've heard it many times, including in movies: In the quantum world, objects cease to have precise, singular locations or states
- Instead, they become **superpositions** of many different possible paths (or histories, or states)




- **This principle works!**
- Richard Feynman used path superposition to create QED, which is one of the most precisely predictive physics models of all time
- Any alternative idea ***must*** replicate these outcomes

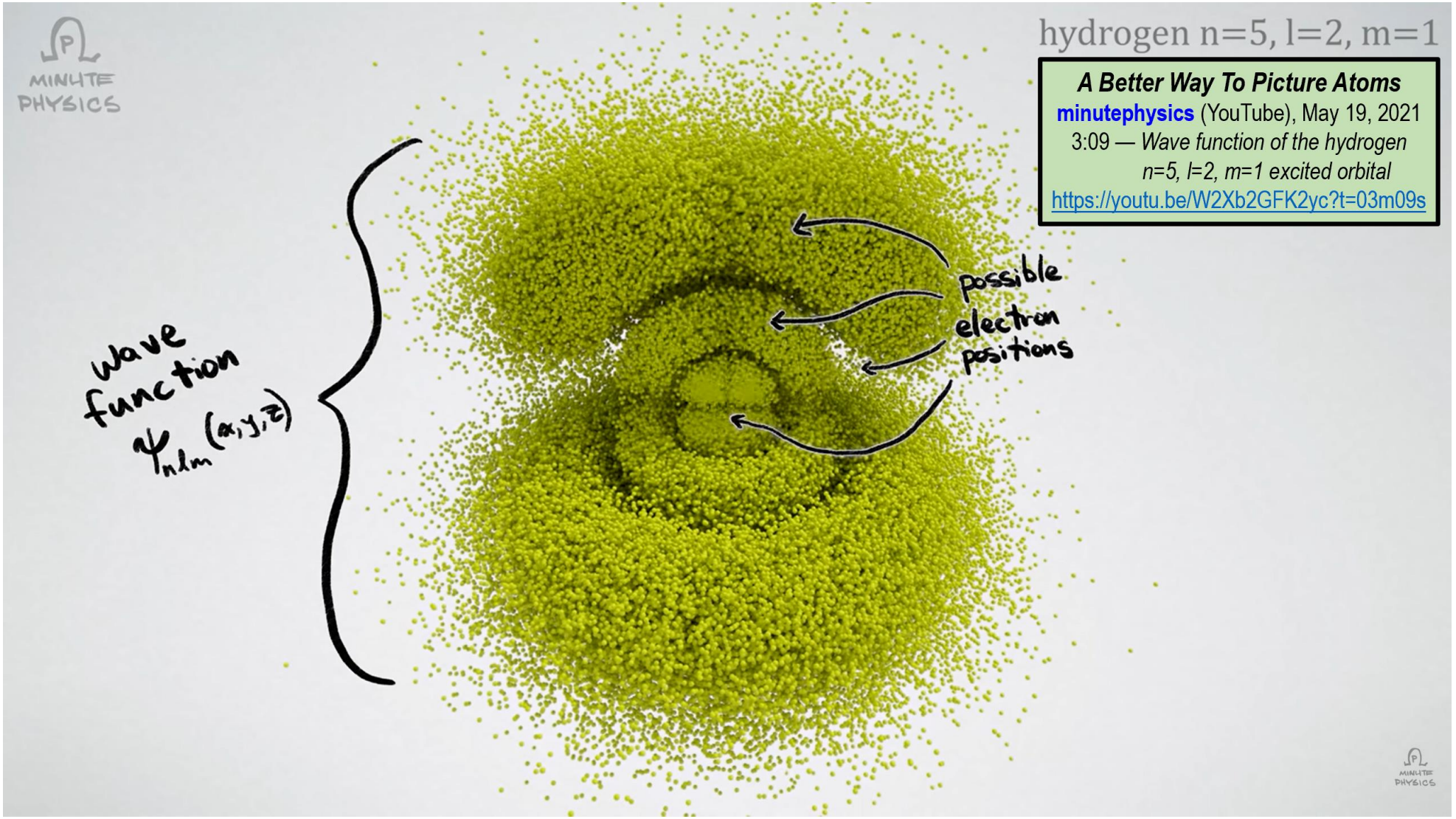
# A Sparse Approach to Superposition

- Monte Carlo simulation assumes that a sufficiently dense number of random samples can characterize over all behavior well
- It is a great fit for QED-style tracking of a subset of particle paths




Source: Aman Behera, Medium.com, Nov 4, 2023

# A Monte Carlo Simulation of an Electron Orbital

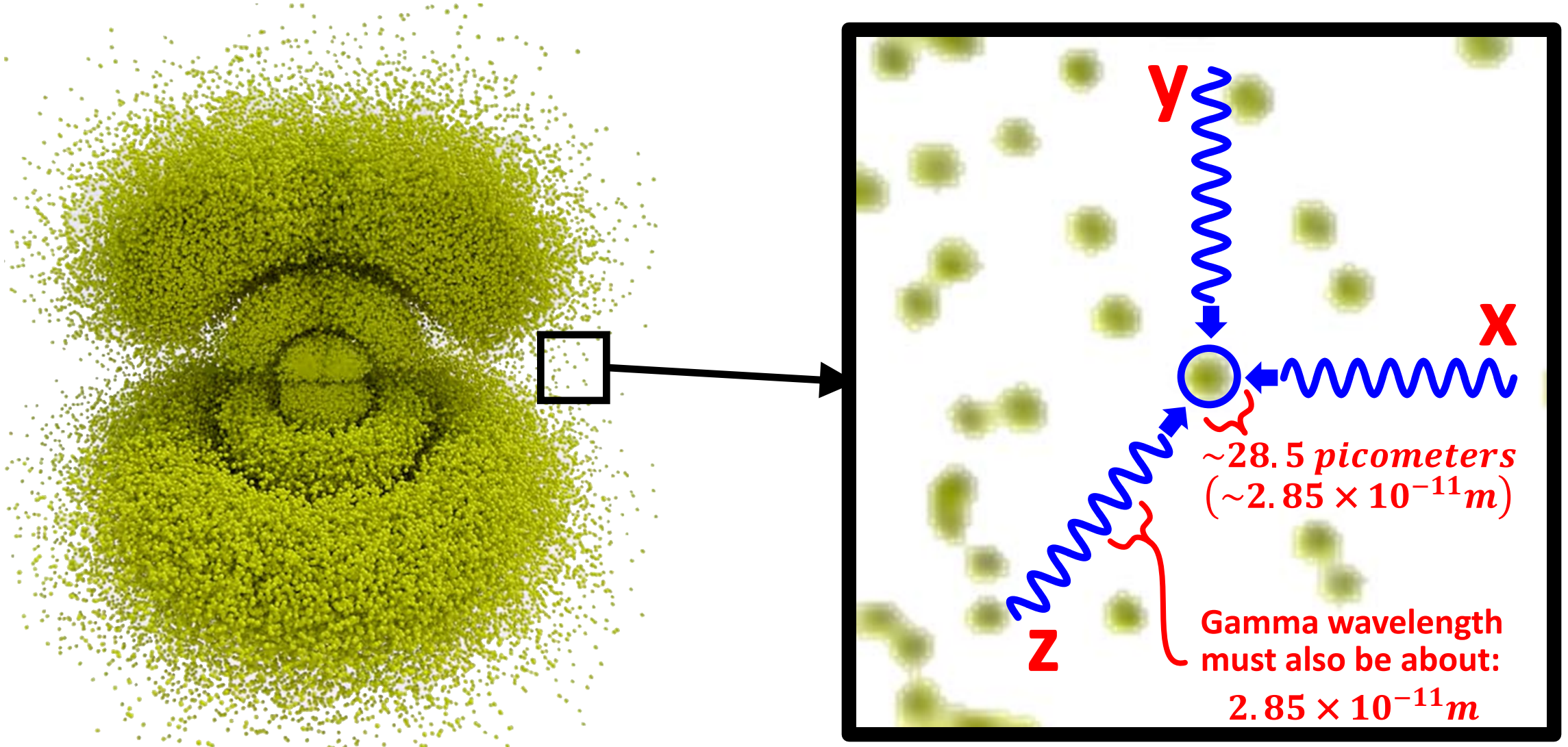


# The Issue that Everyone Knows But Ignores

- Quantum Physics 101: The more point-like you make a particle — e.g., an electron — the more energy you need
- This is why folks keep building bigger particle colliders
  - More energy = more resolution of details inside, e.g., protons
  - At lower energies, particles always look blurry (lousy resolution)
- This is one of the most fundamental rules in all of physics!
  - The need for more energy emerges directly from quantum uncertainty
  - The more precisely you know a particle's location, the less precisely you know its momentum. Uncertain momentum translates into a range of velocities that require higher energies
- How do simulations of quantum wave functions handle this?
  - **They don't**. It is assumed that particles are points as a matter of principle

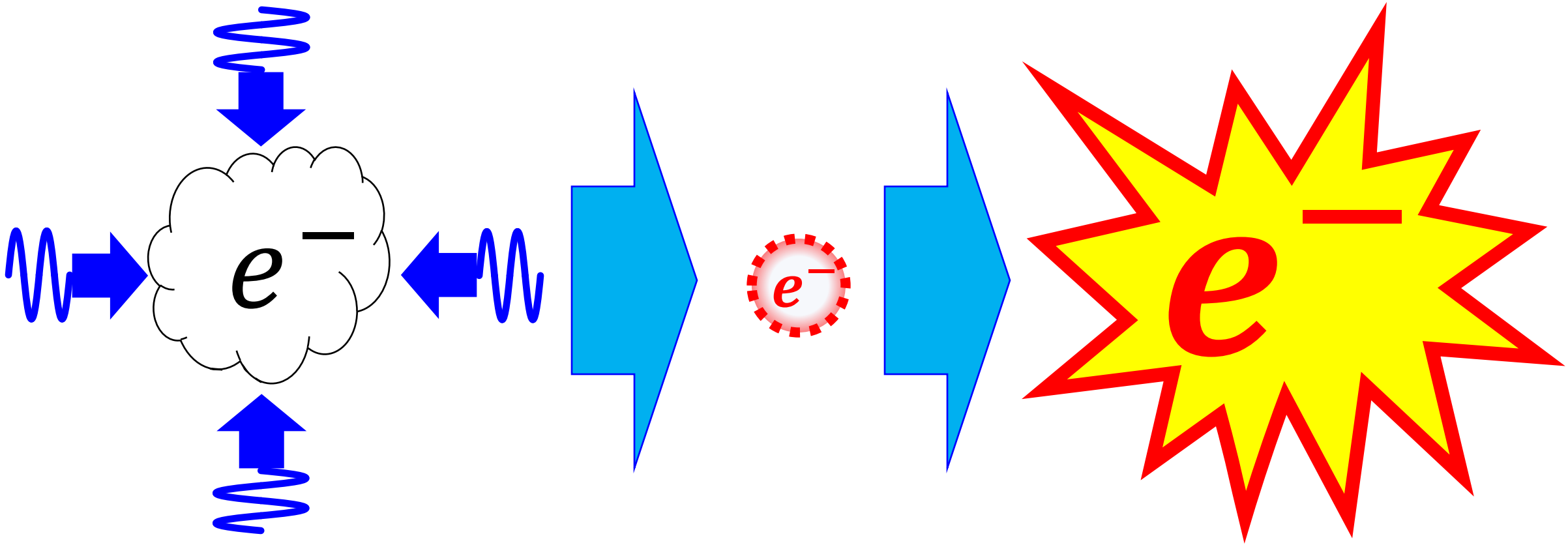
# Part II.
# A Critical Look at Quantum Modeling

# Mapping One Monte-Carlo Electron-Dot into Real Physics

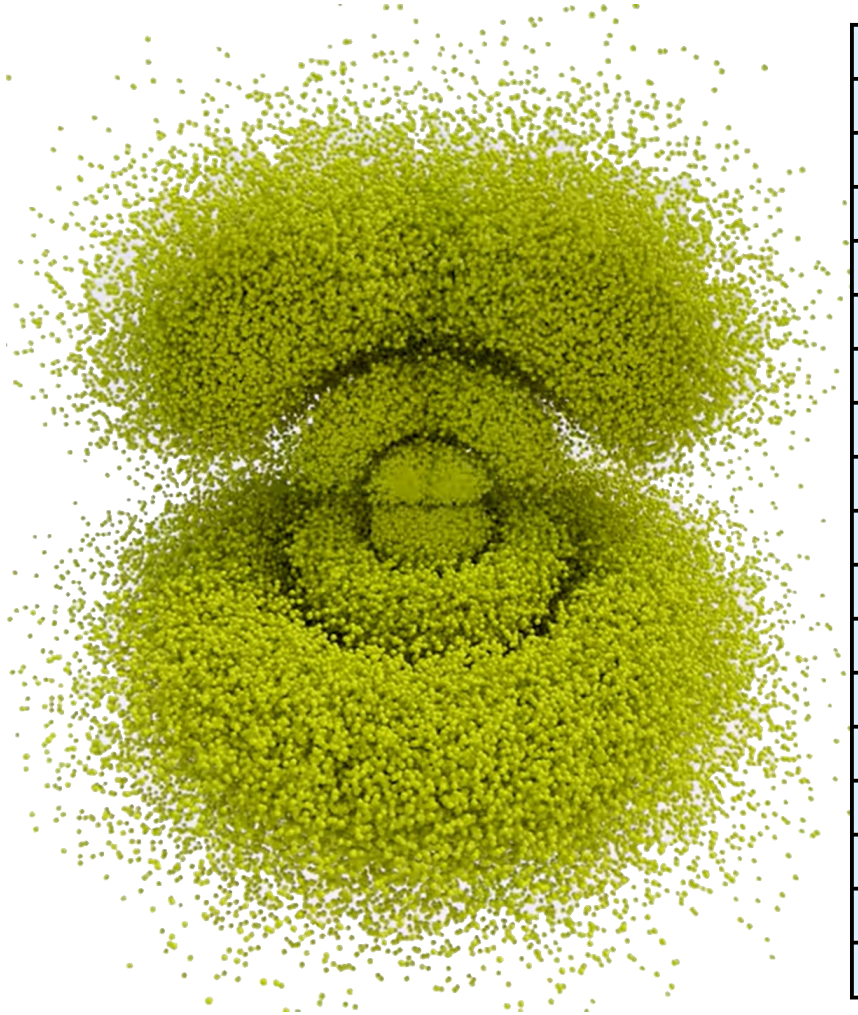


# The Problem of Exploding Point-Like Electrons

- Quantum uncertainty ensures that if you locate a particle very **precisely in xyz space**, it will **immediately explode** into a new wave function that expands at close to the speed of light



# Monte Carlo Simulation Skips Over Energy Issues



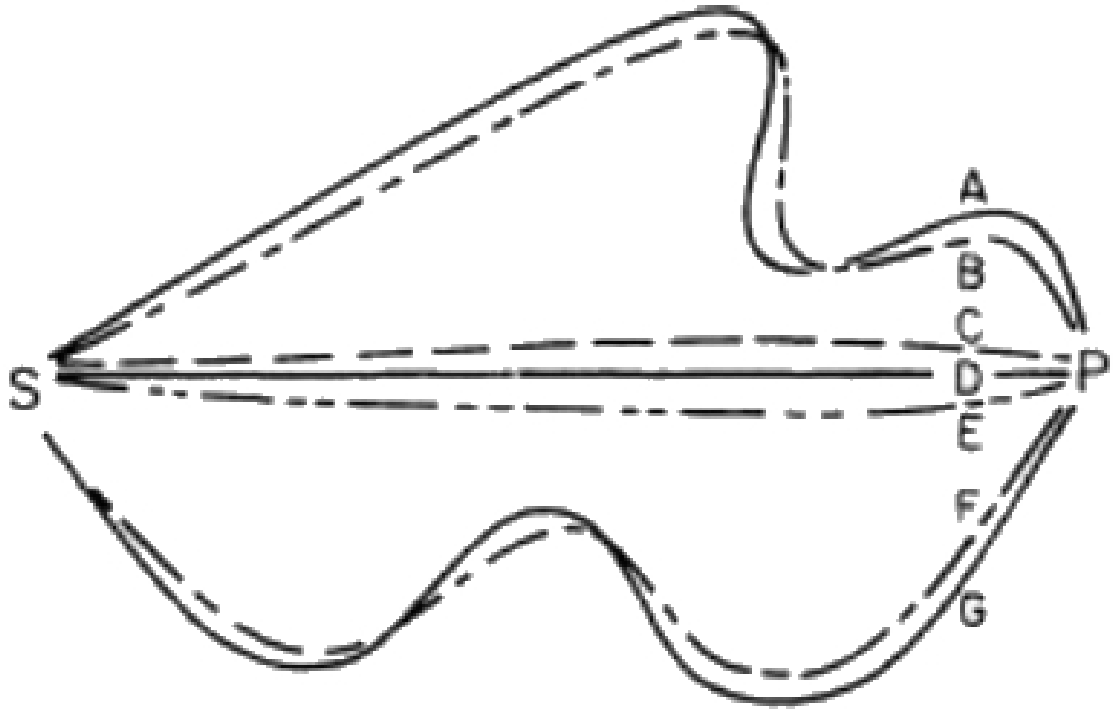
| Calculating the Total Energy Cost of the Orbital Figure | Result | |
|---|---|---|
| Diameter of a hydrogen atom in the n=5, l=2, m=1 state | 3.65 | nm |
| Diameter of one Monte Carlo dot in the orbital simulation model | 28.5 | pm |
| Photon wavelength required to confine electron to a 28.5 pm span | 28.5 | pm |
| Energy of one 28.5 pm wavelength photon | 43.5 | keV |
| Number of axes (x, y, z) requiring 28.5 pm confinement | 3 | axes |
| Total energy cost of one (very brief!) electron-dot confinement | 130.5 | keV |
| Mass of one electron in electron volts | 511 | keV |
| Electron gamma factor per axis, where γ = (511+43.5)/511 | 1.085 | |
| Ballpark (only) post-photon electron velocity based on gamma factor | 0.388 | c |
| Time for electron to cross 14.3 pm (½ of dot diameter per xyz axis) | $1.23\times10^{-19}$ | s |
| 43.5 keV photons needed per second to confine electron on one axis | $8.16\times10^{18}$ | $s^{-1}$ |
| Joules per second (watts) of photons per axis to sustain confinement | 56.9 | kW |
| Watts of photons for x, y, z axes to sustain spherical confinement | 170.7 | Kw |
| Plausible number of dots used in this Monte Carlo simulation | 40,000 | dots |
| Watts needed per Monte Carlo dot to make the simulation physical | 6.83 | GW |
| Power output of a large nuclear reactor | 1.6 | GW |
| **Number of large nuclear power plants to make this figure real** | **~4** | |
| **Number of plants needed for fully smooth orbital simulation** | **∞** | |

*Math is from Gemini, which displayed verifiably correct equations along with each calculation.*

**Conclusion:** The figure does not model reality. It is correct only if you *declare* it correct.

# Feynman's QED Has The Same Issue

- With some slight modifications (see Feynman's QED book), the principle of "every path is possible" applies equally to electrons
- The implication is that, despite their predictive power, each point along a Feynman path is **a point-like state that cannot exist**



# How Do Feynman Figures Handle This?

- Throughout quantum mechanics (not just QED), the standard approach for dealing with infinite numbers of states is to reduce the contribution of each state until it is infinitesimally small
- One can think of this as "fighting infinity fire with infinity fire": The infinities above and below the dividing line end up canceling
- The idea feels satisfying, especially given the success of QED
- There's a problem, however:
  - The infinitesimal approach fails even to address the fact that **none of these paths can exist in the physical world**
  - Trying to build a single Feynman path with an experimentally point-like or near-point-like electron produces **astonishingly energetic explosions**
  - This troubled Feynman enough that he even joked about his Nobel Prize

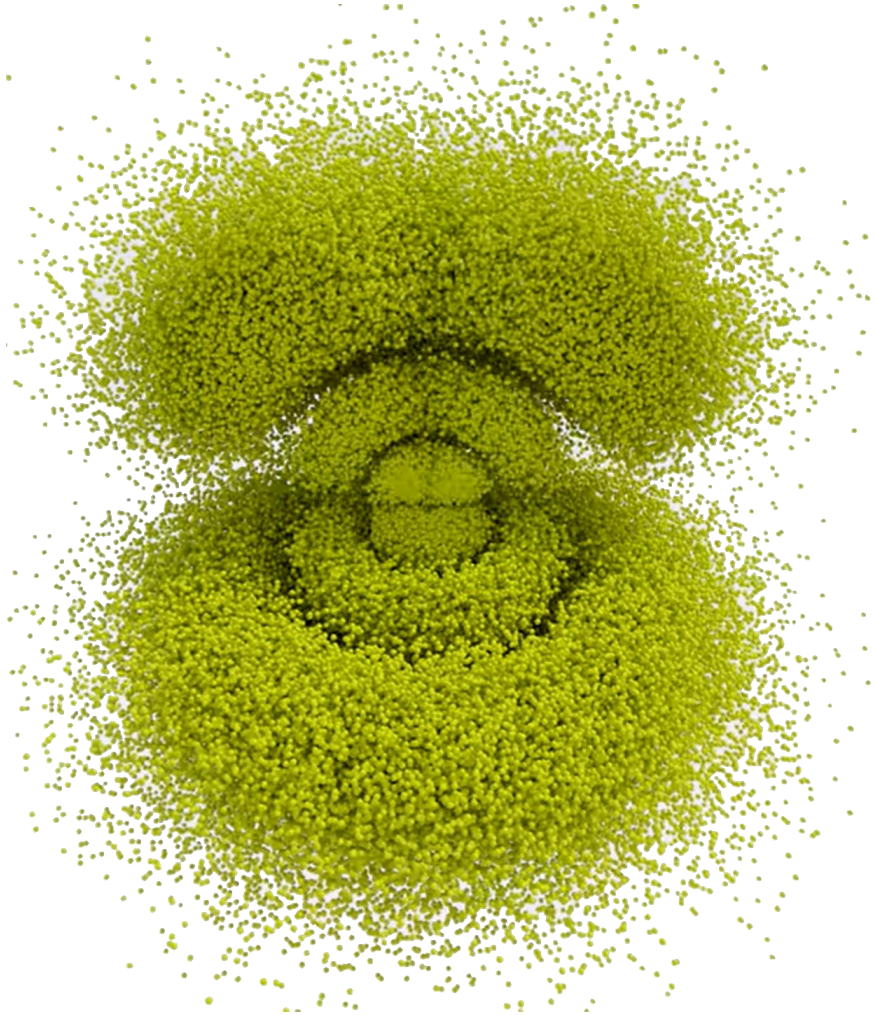
# Feynman's Concerns about Energy in QED Theory

*"It always bothers me that ... what goes on, in no matter how tiny a region of space and ... time, according to the laws as we understand them today, takes a computing machine an infinite number of logical operations to figure out. Now, how could all that be going on in that tiny space? Why should it take an infinite amount of logic to figure out what one stinky, tiny bit of space-time is going to do?" [audience laughs]*

*"So, I made the hypothesis often that the laws are going to turn out to be, in the end, simple like the checkerboard, and that all the complexity is from size."*

— R. Feynman, *The Relation of Mathematics and Physics.* Cornell Messenger Lectures, Nov. 10, 1964. Timestamp 50:56 in the Caltech audio of the lecture. Also available in Lecture 2 in his book *The Character of Physical Law.*

# Consequences



- It is difficult to overstate the impact that using energetically impossible states (and, for momentum, temporally impossible states) has had on quantum mechanics
- Every mention of “many worlds” stems from the intuitions produced by figures like this one, since each particle is a member of one of those “other” universes
- Deutsche made accessibility to all of these dots, and more, the foundation of his gates’
- Gaining access to these physically and energetically impossible states remains the foundation of quantum computing

# Part III.
# A Vital Tangent: The Role of Special Relativity

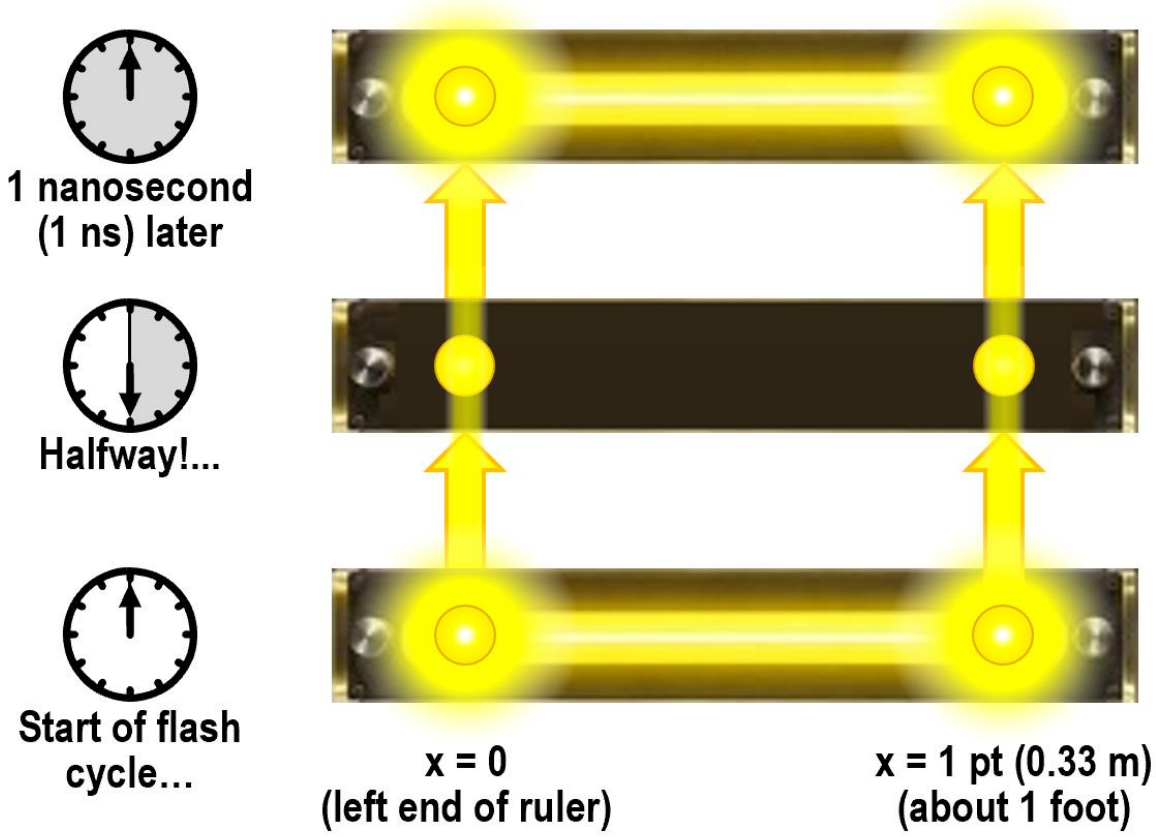
# Why the Tangent to Special Relativity?

- Special relativity is the **theory of inertial frames** — that is, of regions in which the definitions of space and time change

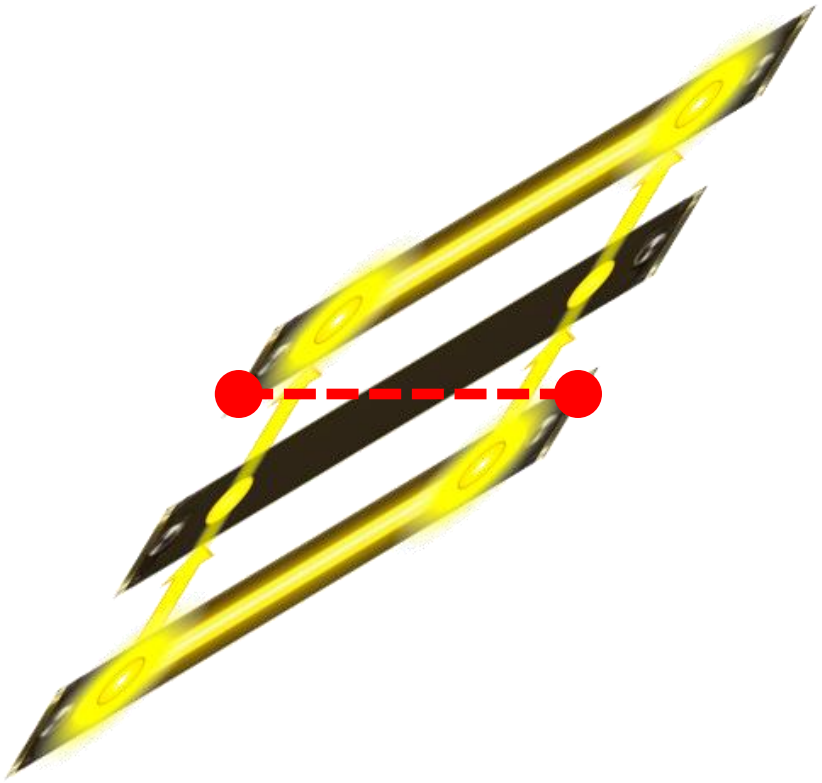
- Generalizing the theory of inertial frames to the smallest scales of matter and energy turns out to be extremely relevant to quantum mechanics, including resolution of the energy problem and the exact nature of quantum observation

# Transforming a Unit Square in Special Relativity

- The device below is a neon light bar with timed flashers on either end
- To understand special relativity, you only need *two* dimensions, x and t
- The light bar "draws" a one-nanosecond unit square in space and time

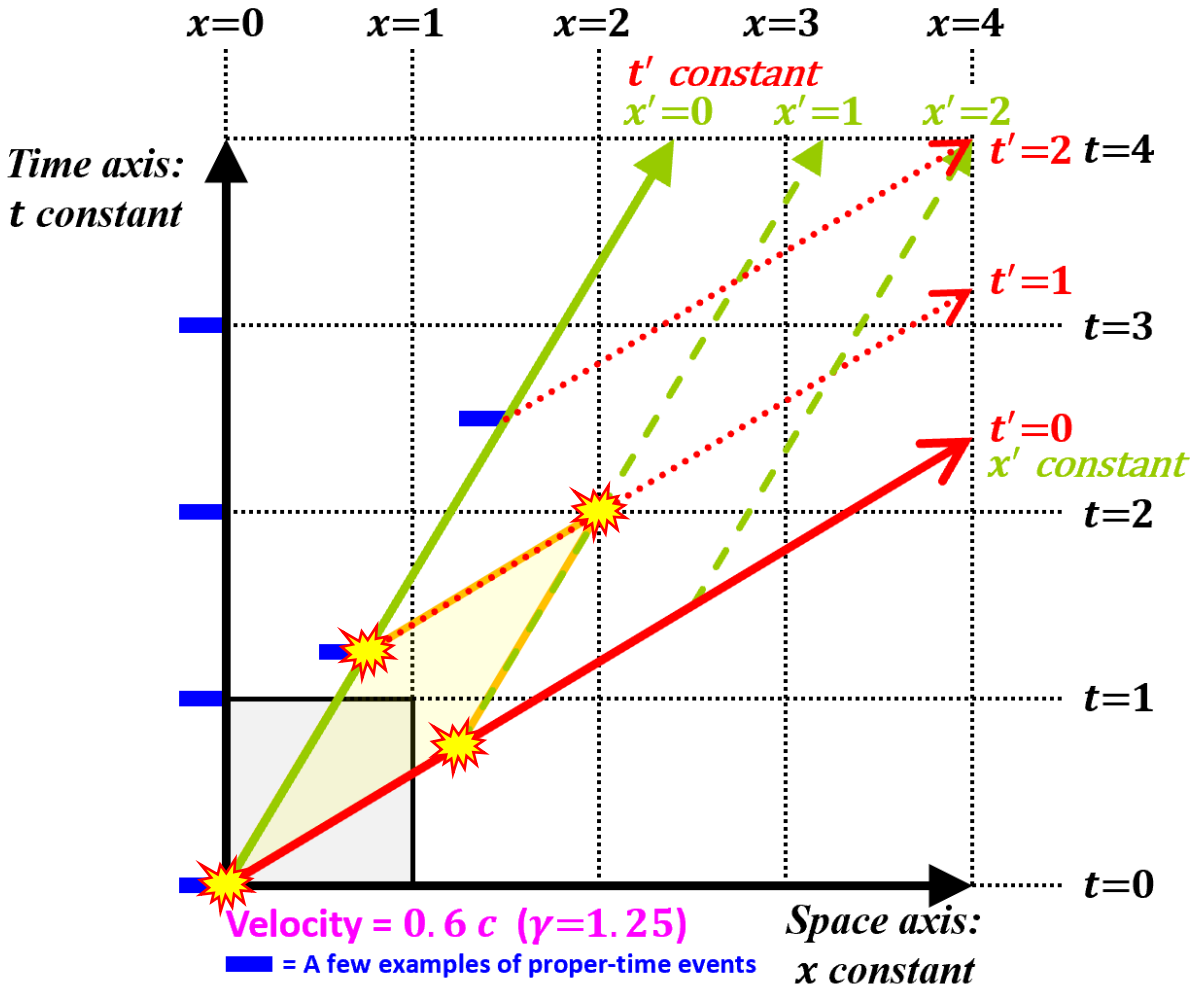


# What Does a Unit Bar Moving at 0.6 c Look Like?



- Here is the same unit bar moving past at 0.6 c (60% of the speed of light) along x
- If you were expecting to see Lorentz contraction… Surprise!
- In the full spacetime view, objects become *stretched* in space and time, not compressed
- The Lorentz contraction is there, just hidden in the red horizontal line
- Lorentz contraction is an example of a *frame-to-frame* interaction

# Attaching Coordinate Systems to the Light Bar

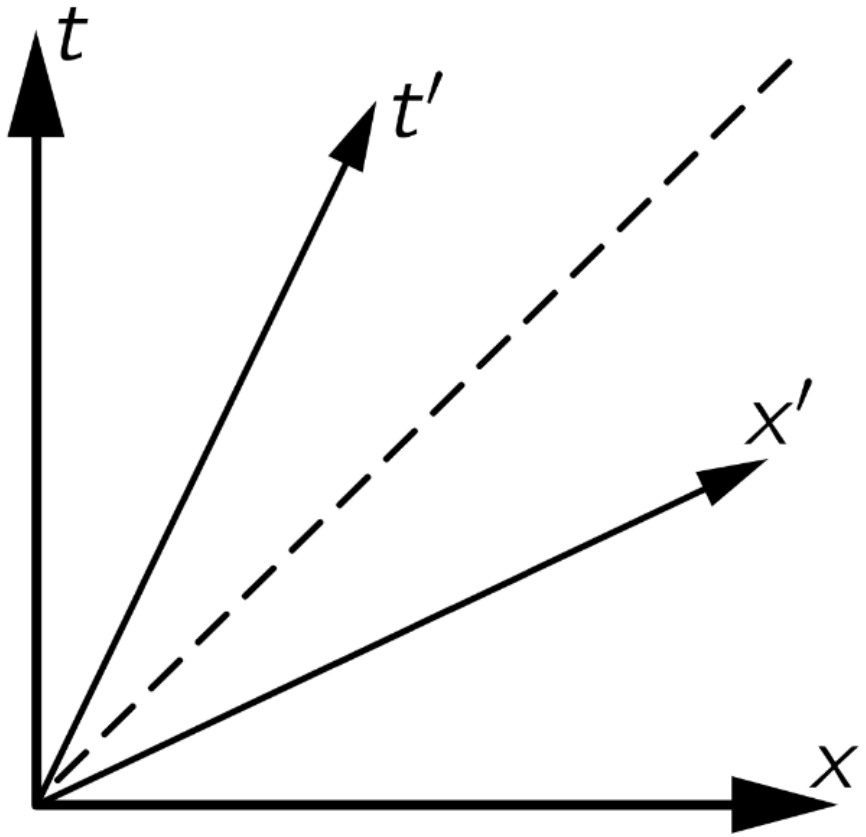



Source: https://iep.utm.edu/proper-t/#H14

- Using a figure from the Internet Encyclopedia of Philosophy, here is how the fast-moving neon light bar looks as it passes
- The gray square shows the comparative location of an unmoving light bar
- Notice that the moving light bar always traces out a rhombus whose sides stretch out as the velocity increases
- An interesting “shortcut”: The areas of the unmoving square and moving rhombus are always the same

# Feynman's Version of the Same Coordinates

- Original Feynman figure (edited here to show only coordinates): https://www.feynmanlectures.caltech.edu/I_17.html#Ch17-F2



# Time for a Surprise

Here is one version of the Lorentz equations for converting the unit $xt$ square into the unit $x't'$ square. They were discovered by Woldemar Voigt in 1887:

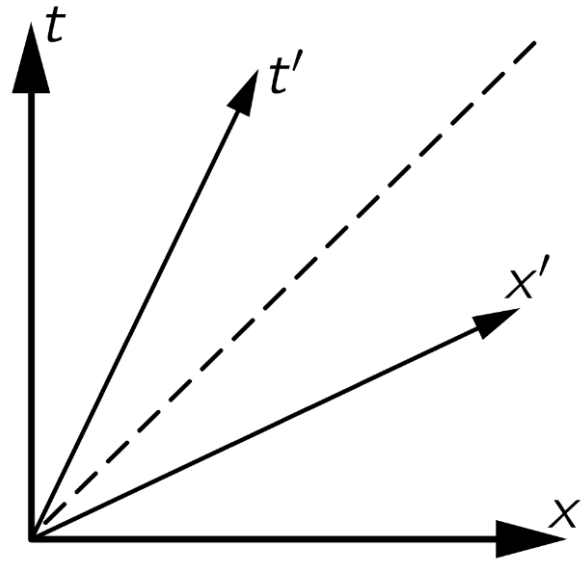
$$x' = \gamma\big(x - t(\beta c)\big)$$
$$t' = \gamma\big(t - x(\beta / c)\big)$$

Where:

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

---

Here are the $xt$ and $x't'$ axes from Feynman's lectures:

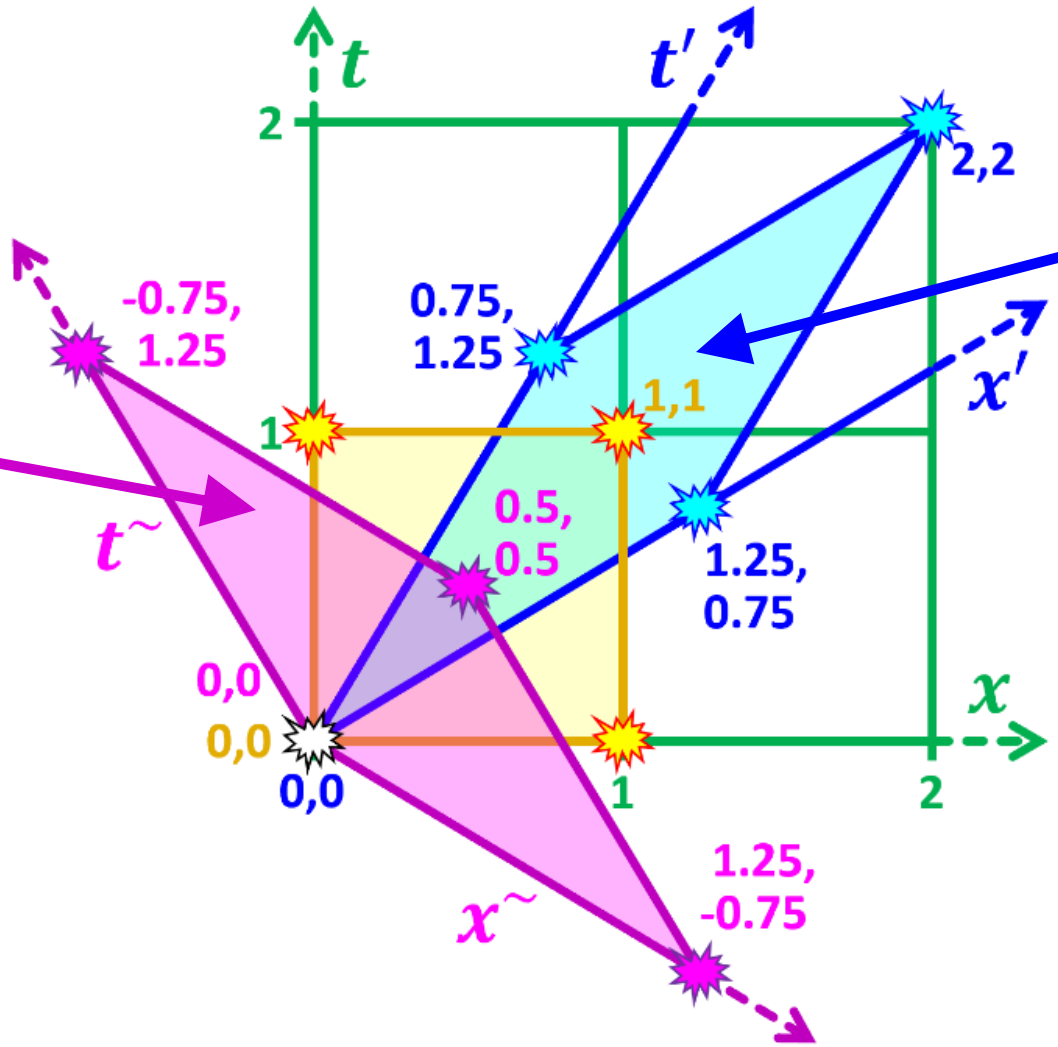



**The surprise**: The **$x't'$ variables** used in these two very standard examples **are not the same**

# Part IV.
# Houston, We Have a Problem

# Houston, We Have a Problem

Transformation of the light-bar unit square using the **Lorentz equation definitions** of $x'$ and $t'$ (**FLATLY INCORRECT**)




Transformation of the light bar according to the **axes definition** of $x'$ and $t'$ (**LABORATORY VALIDATED**)

# A Quick Resolution (for Now)

*Here is the summary, for now, of the situation:*

## WRONG FRAME MAPPING

$$x' = \gamma\left(x - t(\beta c)\right)$$
$$t' = \gamma\left(t - x(\beta / c)\right)$$

Where:

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

- When comparing two frames, this leads to a mixed-signature Minkowski space
- You can no longer use Euclidean

## CORRECT FRAME MAPPING

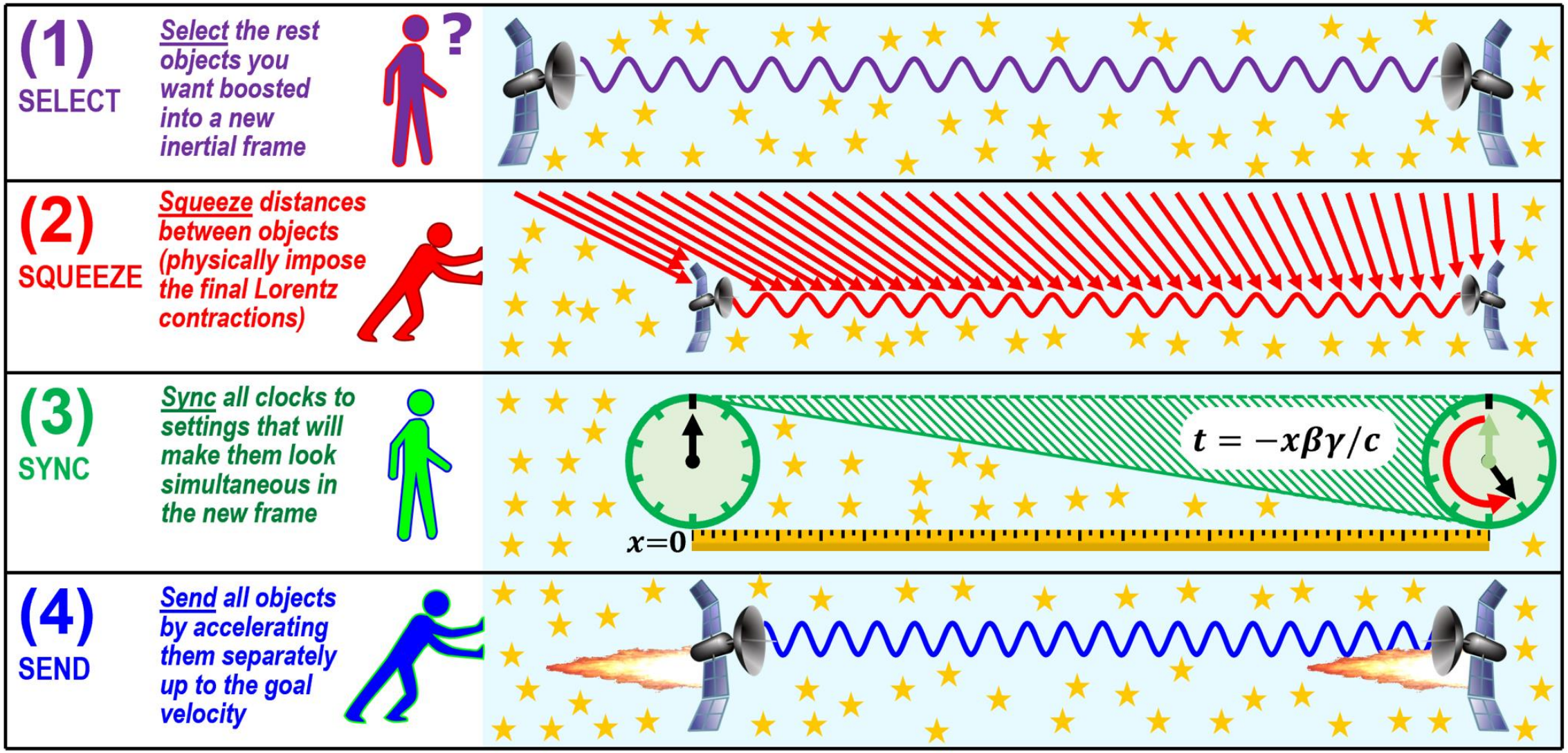
$$x' = \gamma\left(x + t(\beta c)\right)$$
$$t' = \gamma\left(t + x(\beta / c)\right)$$

Where:

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

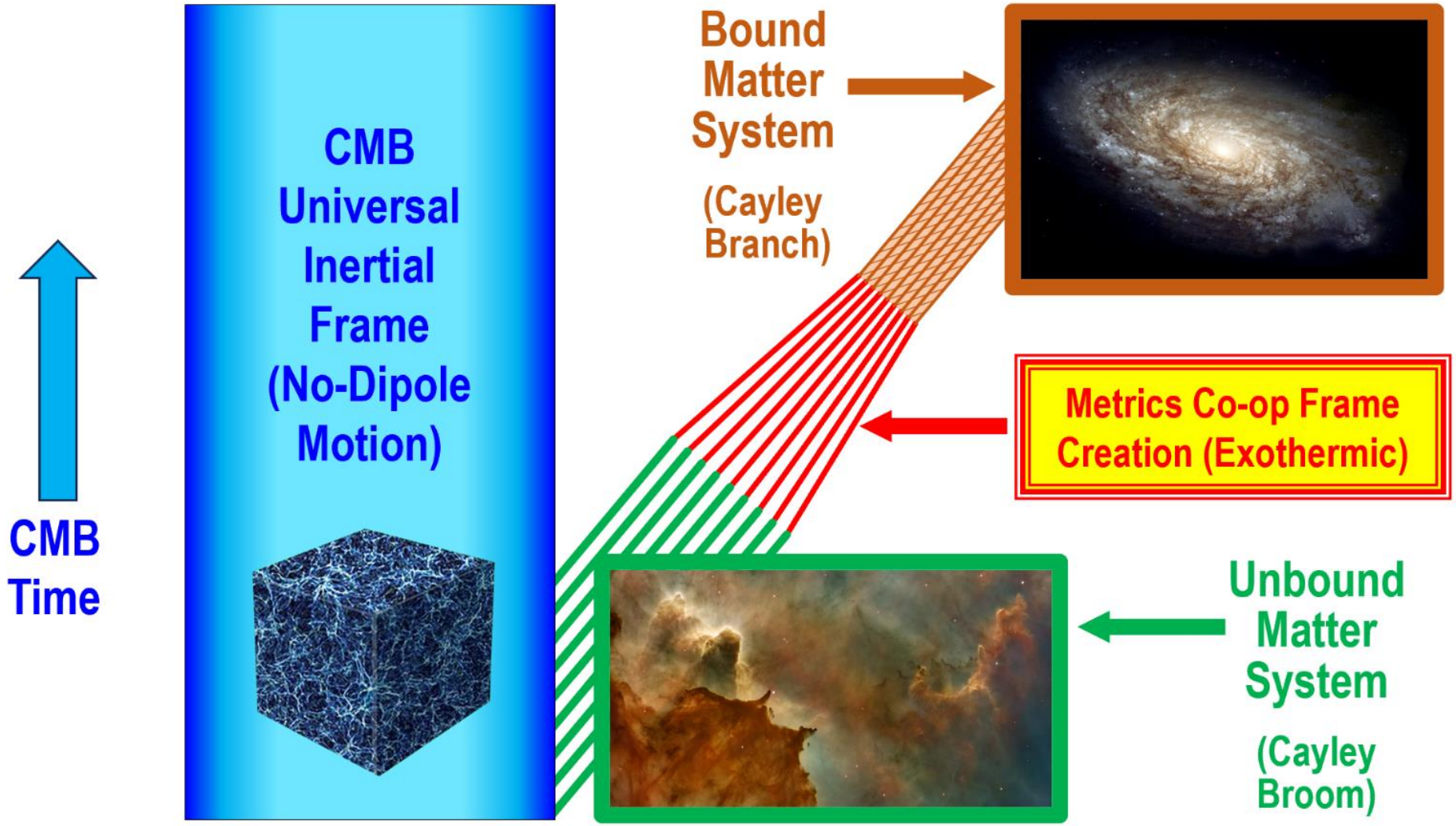
- When comparing frames, this leads to **fully Euclidean spaces** that fully preserve causality
- "Block" universes are *not* needed

# Frames Become Finite-Sized "Flat Space" Entities



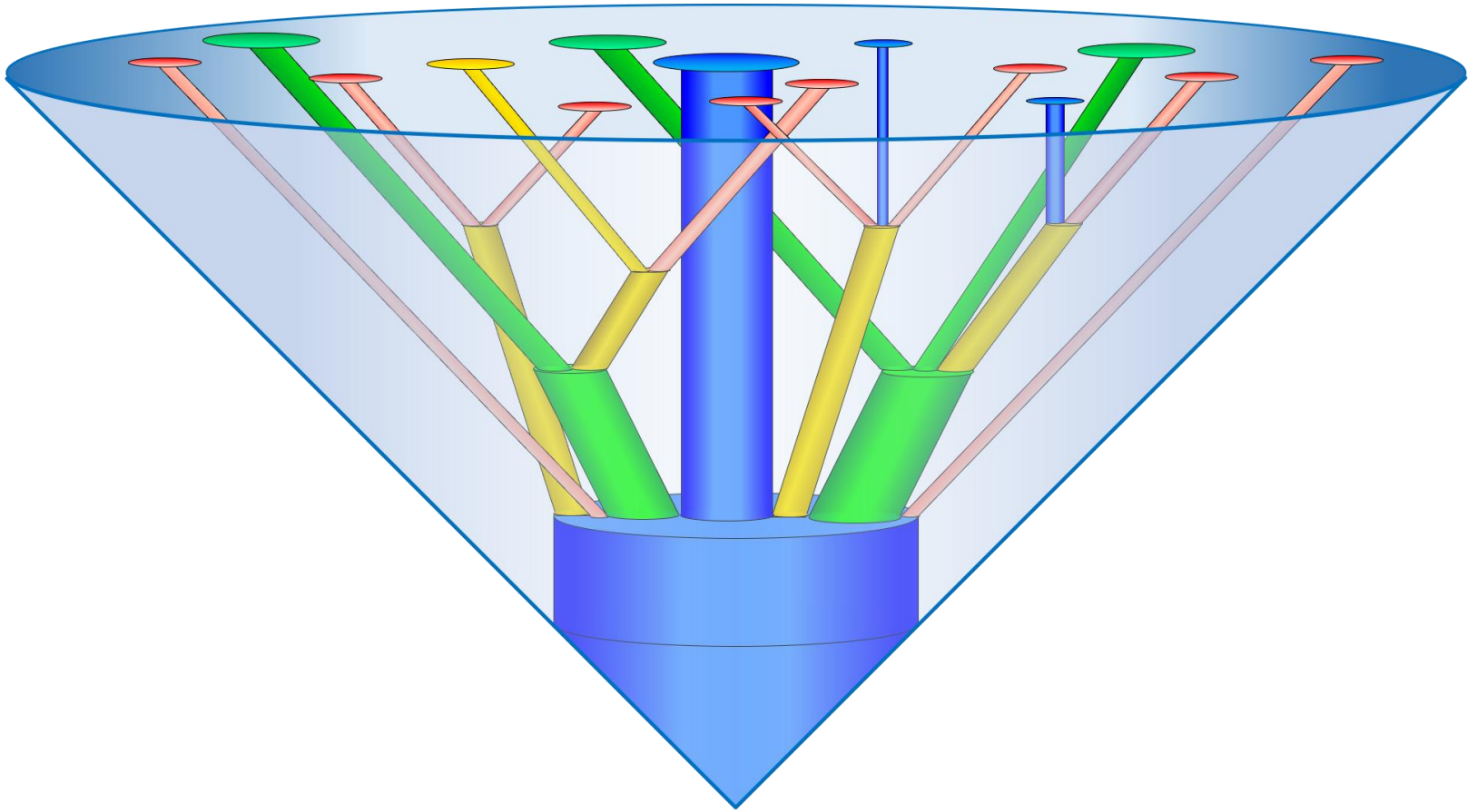
# Part V.
# The Cayleyverse

# New Frame Creation is an Exothermic Reaction

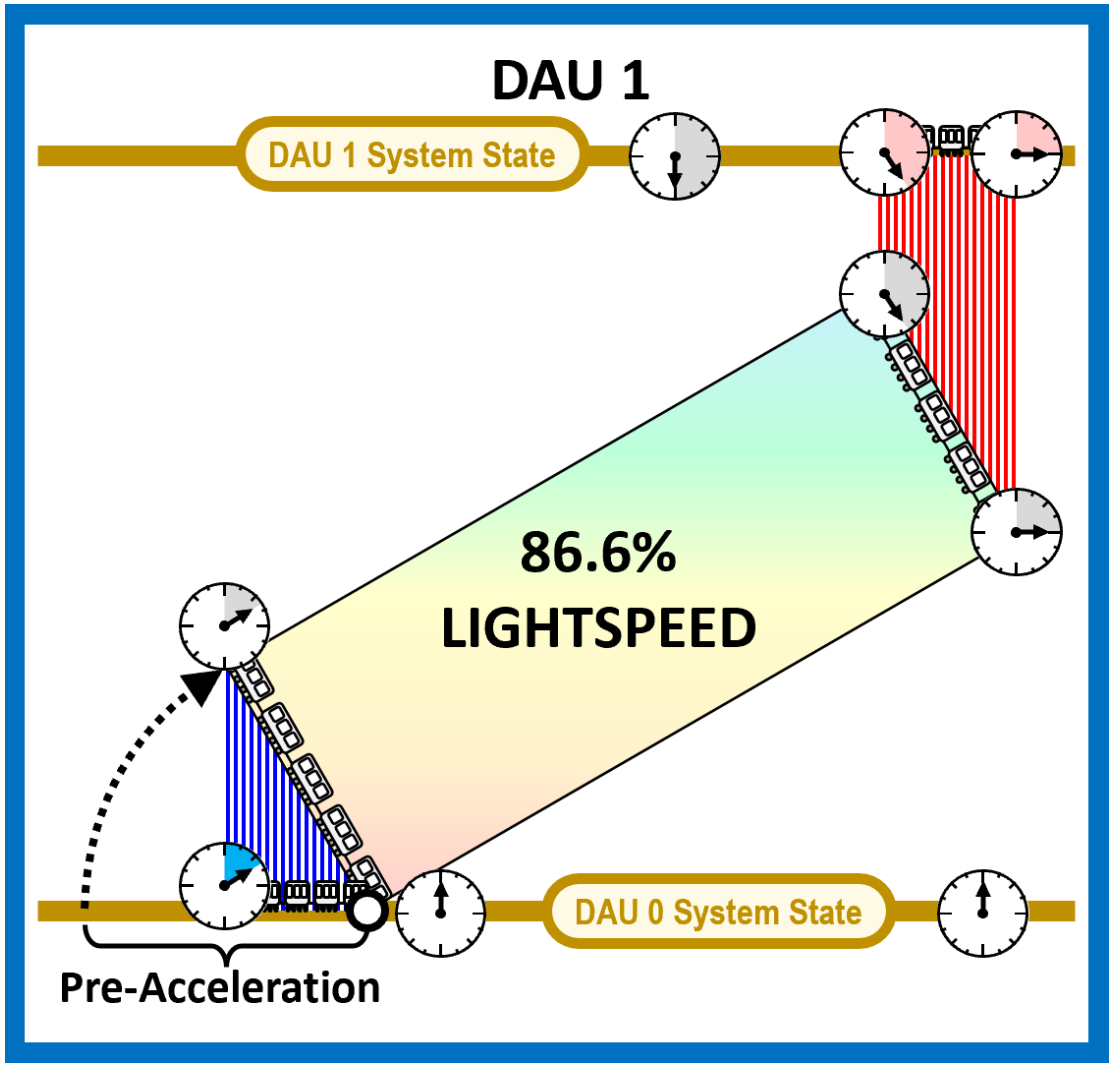


# Result: A "Cayleyverse" of Branching Frames

- **IMPORTANT**: Old frames **do not disappear**; they **superpose**.

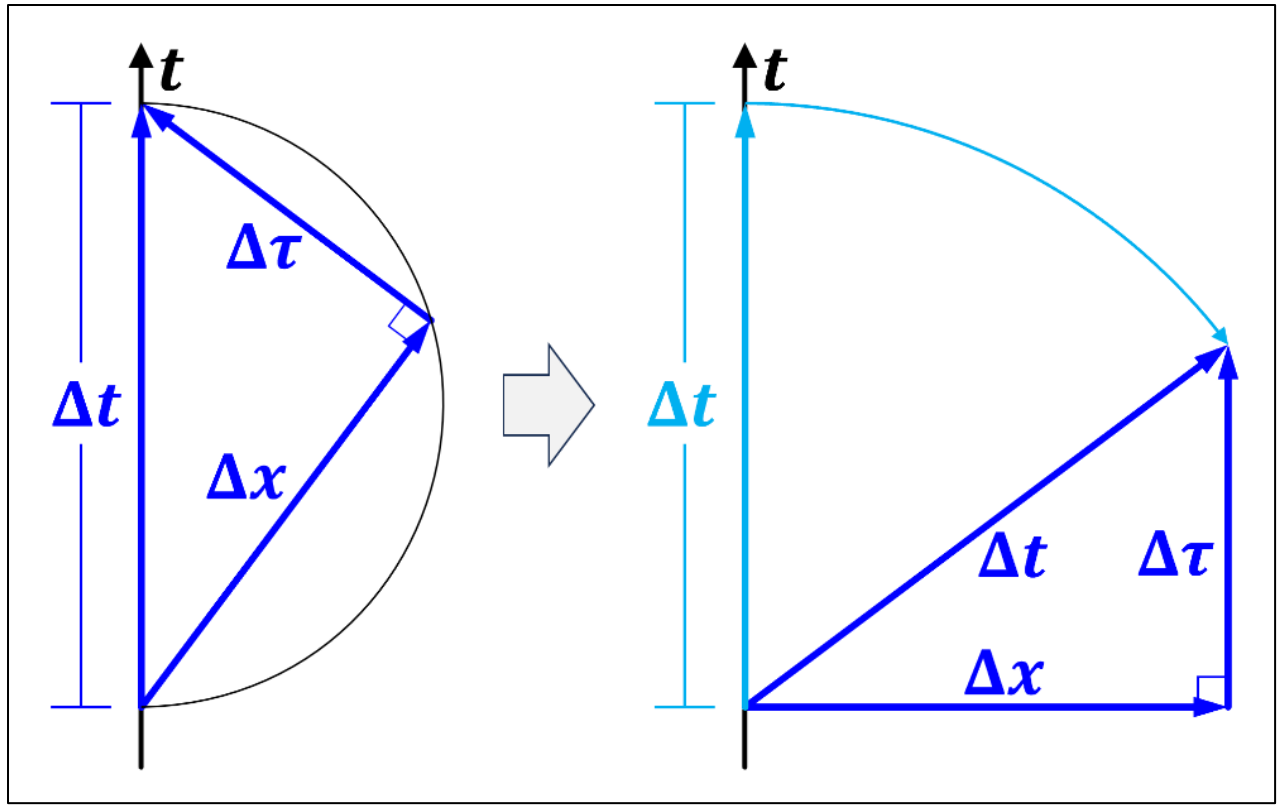


# Clock and Ruler Conversions Become Easier

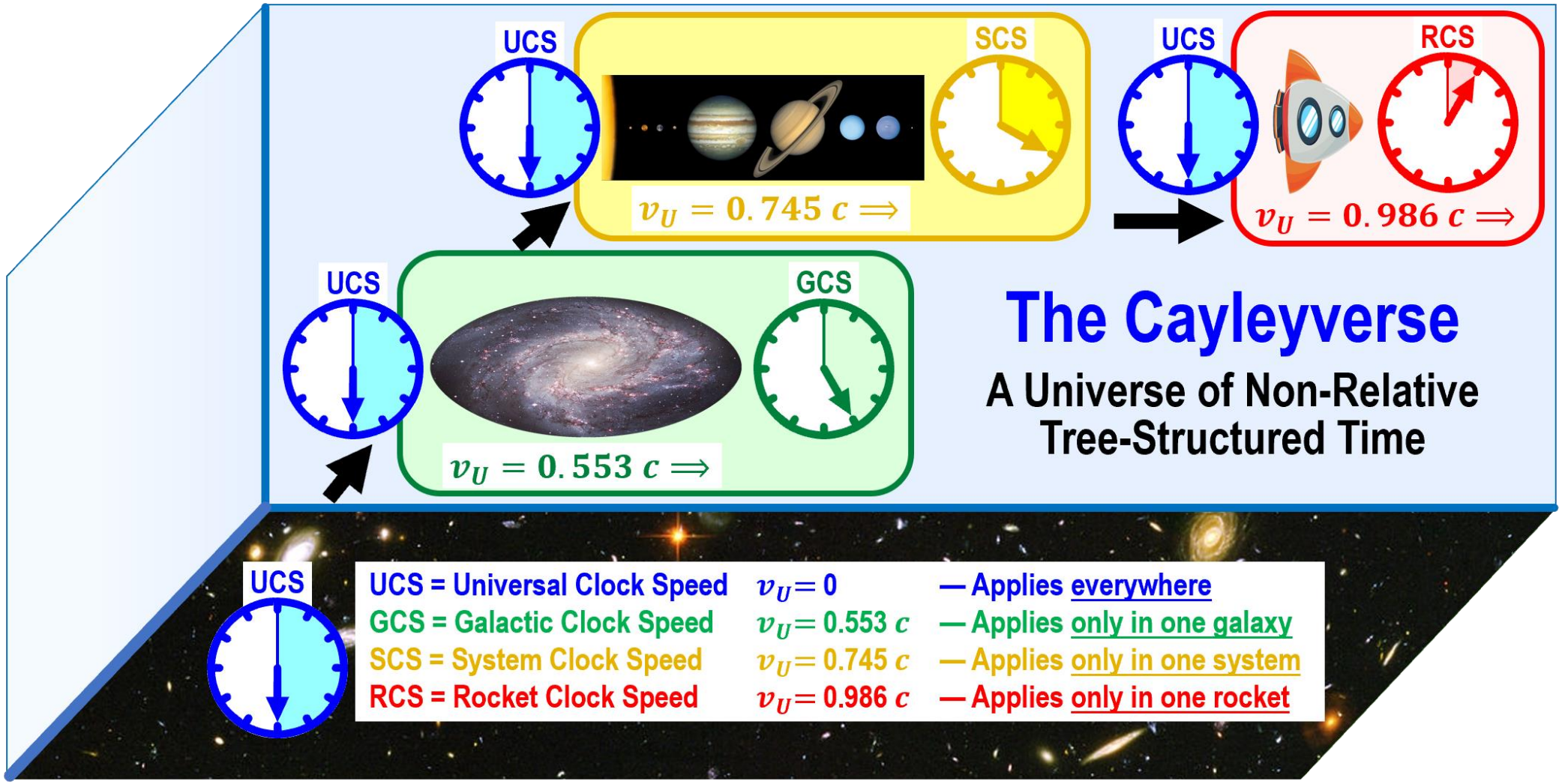


# Another Euclidean Conversion Example

- Time as measured in the launch frame converts to distance and actual change (proper time) in the new frame

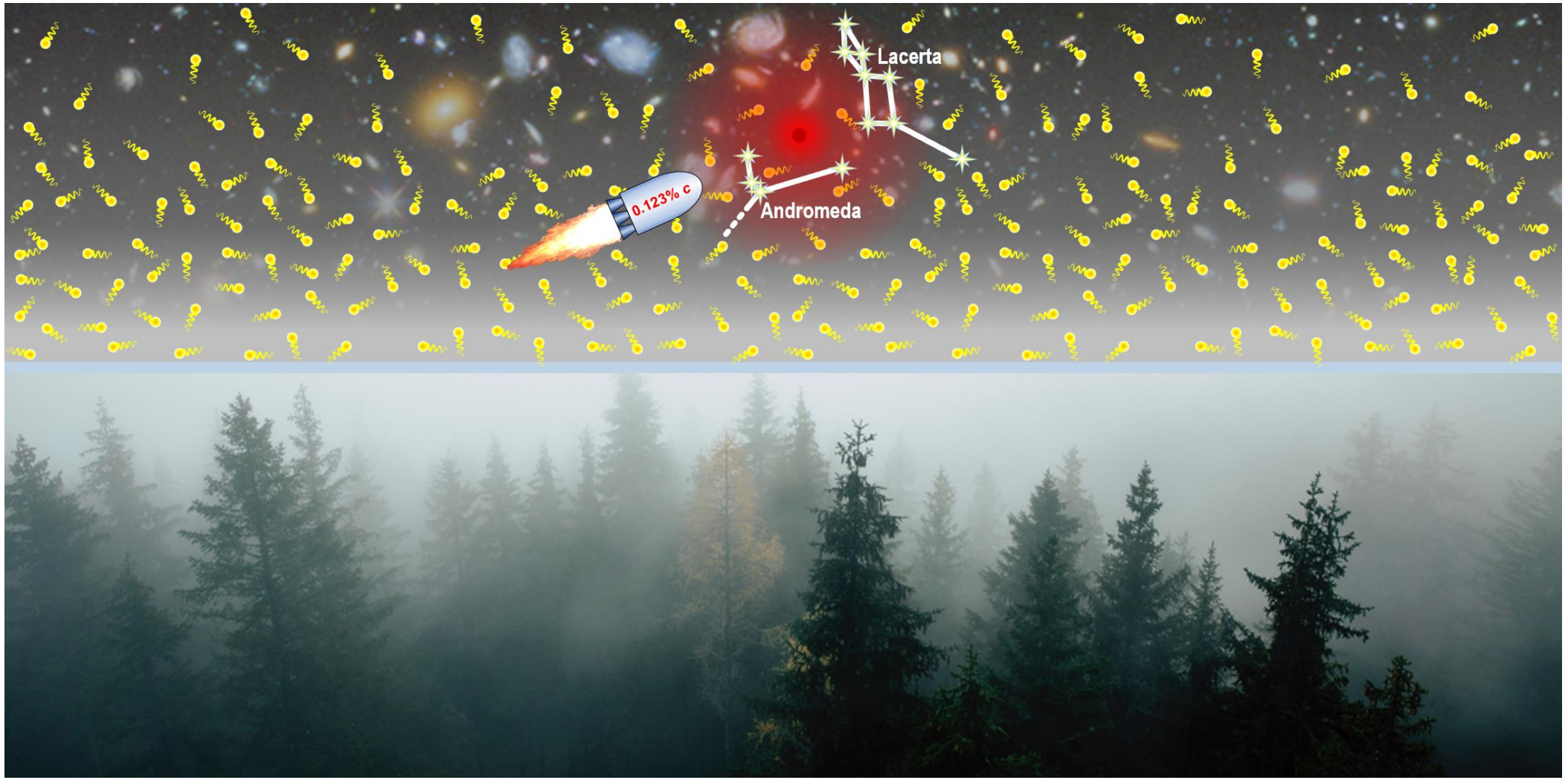


# The Entire Universe Participates



# Do You Want to Rejoin the Fastest-Time Universe?

*Here's how. You will need a very good rocket ship.*



# Part VI.
# The Bumping Problem

# The Bumping Problem

- **Theorem 1**: The entities within the flat space of a newly created frame are profoundly quantum entangled
- This "attaches" frame creation to entanglement in an adversarial fashion: Creating a new frame destroys old entanglements
- The implication is this:
  - Any "bump" — any collision of two entities — collapses the entanglements of *both* entities with older frames
  - The result is a dramatic collapse in causal Euclidean space of the "scope" of the frames
- **Theorem 2:** This special-relativity-induced loss of entanglement is identical to the quantum concept of "wave collapse," and can happen even when the momentum exchanges are very small
- **Theorem 3:** Classical physics is just maximally collapsed physics

# Part VII.
# Back to the Quantum Energy Problem

# Space as "Pointers" Stored in Matter

- Believing that space and time are *more* fundamental than matter has a variety of (mostly deleterious) consequences:
  - Overlapping inertial frames become difficult or impossible to comprehend
  - Infinite-energy problems become unavoidable (the Monte Carlo problem)
  - Connections between spacetime and particle physics are obscured
- **An alternative:**
  - If frames are finite objects attached to matter, "space" necessarily becomes a set of (likely hierarchical) relationships between actual matter and energy within that frame
  - **Theorem 4:** The total capacity for entities to represent space relationships *internally* depends entirely on their mass-energy. Since it is embedded in larger, higher-mass frames, this finite embedding appears to the larger frames as uncertainty in the metrics that define the smaller entity

# Bottom-Up Causality

- Rotation (angular momentum) is repeated localized "bumping."
- **Theorem 5:** Particle spin is "self-observation," and is the first and most fundamental step in creating a universe with memory, causality, and history
- **Theorem 6:** All causality is bottom-up, starting with spins and moving upwards via various forms of force binding (which creates higher levels of self-observation). This hierarchy includes gravity.
  - Bottom-up causality provides a very firm and somewhat trivial resolution to Schrödinger's cat, one that Schrödinger would have liked: Superposition of complex internal object states is flatly impossible
  - The Schrödinger cat either dies or lives — always.
  - The issue of the *location* of the cat, however, remains very much open
  - Location belongs to the full hierarchy of frames, not just the cat

# Incomplete Spaces

- If the space pointers of particles are strictly limited by available mass and energy, what happens for very small particles?
- Easy enough: They lose the ability to define space and time fully, and so start exhibiting subset behaviors such as interfering with themselves over time (because they see no internal time)
- Fermions, for example, can point along one axis (two opposite spin states), but not much more. Vector bosons have states that look like three dimensions *because* they have sufficient new state storage to maintain full connections to their local frame space
- There are no strings, geons, multi-worlds, or vacuum density problems in this model. Gravity is quantized, but only in the sense that its level of resolution is strictly limited by available matter.

# Part VIII.
# Summary: Back to Quantum Computing

# A Non-Paradoxical Superposition Model

- Once space is reduced to not much more than pointer entries in small, locally-owned, matter-limited spreadsheets, an entirely new model of superposition becomes possible:

  The only entities superposed in quantum mechanics are multi-scale definitions of spacetime. The entities themselves exist and change internally without any need for specific locations in the larger universe, and they remain singular and finite at all times.

- This combination resembles a pilot-wave model (which was a big surprise to me), but without the particles ever traversing "real" space; e.g., they never move through one or the other of two slits. The slits merely induce a novel set of updates to location entries.

# Implications for Quantum Computing

- All variants of the Deutsch model are wrong
  - This does not mean they are not useful, since they still encode the same basics of quantum mechanics as Feynman's QED (which is also wrong)
  - However, pursuing any variant of "real" particle paths implies infinite energies that are the opposite of the goals of quantum computing
  - The Deutsch model needs to be buried and forgotten. It was a good try at the time, but it didn't work, and it is now impeding progress.
- What is needed is a new framework that shifts the same work done by QED from the particles (no more infinities of images of a single particle), and replaces that work with a new algebra of the properties of finite special relativity frames — which were the real "wave functions" all along. The wavy part does not show up well at classical scales.
- The new model of quantum computing will be more like "dueling spreadsheets," which I find both apt and amusing. The trick will be to tickle computation out of the multiple levels of highly entangled "flat space" frames.

