

Revisiting the Mixed-Signature Foundations of Special Relativity

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[0:0] TB: [Good morning, everybody. This is] one of my continuing talks on the topic of special relativity.

I've actually done quite a bit on this topic before. So it's not the first time that I've addressed some of these issues. *This one* has been interesting for me because on going through some of the issues of how to represent transformations in special relativity it turns out that there's some interesting abstractions (some interesting mathematical abstractions) that work quite well with it and they are in keeping some of the things I've said before about how we need to approach special relativity, but they also give a specificity that I haven't had before with this.

So, [it's] been an interesting series. I have quite a few slides. Many of these are more just to explain where the mathematics is coming from and the steps on that. So, some of them... I'll go through it pretty quickly. There's a total of 64 slides, so I need to keep a good pace on what I'm going through with these.

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November 8, 2025

Overview

- The Minkowski formalism of special relativity has some difficulties:
 - It does not handle or predict large-scale, **multi-frame interactions** well
 - It does not model the process of **acceleration** with sufficiently specificity
 - Assertion: Using **mixed signatures (+++ – for $xyzt$) is not fundamental**
 - Minkowski space typically assumes that the existence of **spacetime is independent of matter** (and yes, that can be a problem)
- This presentation develops two new formalisms:
 - An intuitive **tilted-block formalism** that uses only Euclidean space
 - An unexpectedly simple **quantum-like phase rotation method** that predicts SR while also resembling quantum mechanics

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[1:13] Now, the Minkowski formulation of special relativity is just standard... nothing... the standard formulation's been around for 100 years. This is the formulation that Minkowski created based on what Einstein had been talking about, one which Einstein did *not* agree with when he first saw it. In fact, he *literally* said that he was not sure what the mathematicians were talking about.

And... I've thought about this a couple ways. I could just go after this and say, that... you know... try to say all sorts of nice things about the Minkowski representation, but the problem is that in order to *say* where the lack of specificity comes from I have to say some things about the Minkowski representation that... where it does *not* work well, despite the fact that it's very deeply embedded in a lot of mathematics.

It breaks down in certain areas, especially when you have interactions between multiple frames. It doesn't model acceleration very well. In fact, it really doesn't model acceleration *at all*. It simply accepts that as a given and therefore discards the history that goes into that.

The idea of using these mixed signatures, the idea that time has a negative signature... there are good reasons for doing that mathematically, but they also are a *choice*, they're a decision, and by making this decision, what it does is it focuses much more strongly on the *final result*, and not so much on how you get *to* that final result.

So it's kind of a subtle difference, but it *does* make a difference in terms of what you can end up predicting. The multi-frame interaction issue is a consequence of that. Probably the *deepest* and *most* heavily embedded concept that Minkowski space encourages is simply the idea that spacetime is independent of matter. Now, if you've watched some of the presentations I've given before, this is an issue that I think is *really* important to address with care, because if we think spacetime is a completely separate entity that does not exist outside of matter (which many people firmly believe that's true) then you start having difficulties describing the relationships of the material objects inside of that space-time in a way that really, truly connects them to the spacetime.

You see this in the disparity between quantum theory and spacetime. That was why Einstein did not like the Minkowski representation. Early Einstein, up to 1911, totally focused on clocks and rulers. He focused on material objects, because in his view at that time there was no other way to get specific laboratory-meaningful test

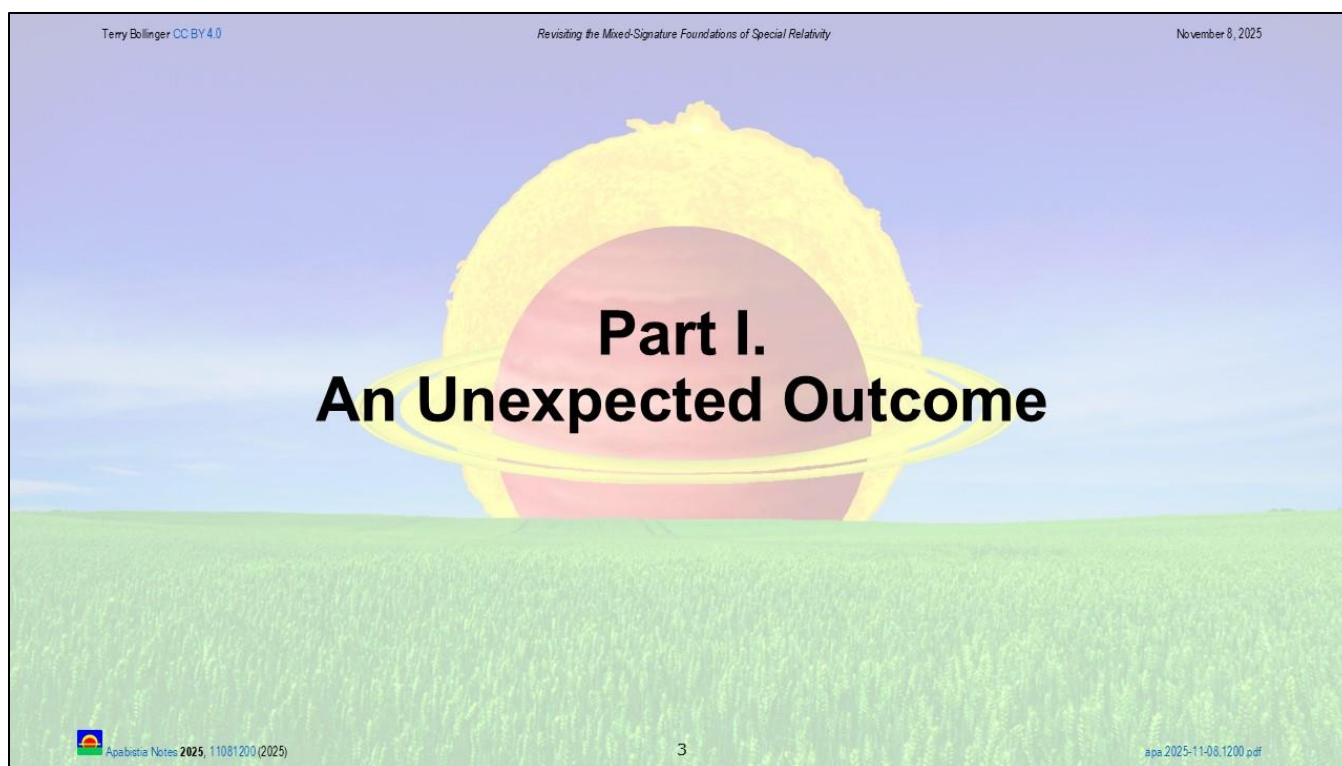
results unless you used an object, and that is still true today, because no matter how we may *talk* about the idea of quantum foams and all these other concepts, until you have an energy level that actually accesses those concepts you don't have any meaning to the structure.

You have to have some kind of energy, some kind of matter, some kind of instrumentation. to make a specific reading, and at that point you don't have empty space anymore. It's a simple dichotomy that... you know... you can talk about empty space having properties but if the only way you can measure those properties is to put matter or energy *into* it, *then* you have to be a little careful about what you're saying. Are you really truly saying that or are you just assuming the spacetime's there and it doesn't matter how much energy you had to put in to get to it. That's a little dangerous because empty space has to have matter and has to have energy to measure the properties, which takes you right back to the idea that matter is very closely related to our concepts of space.

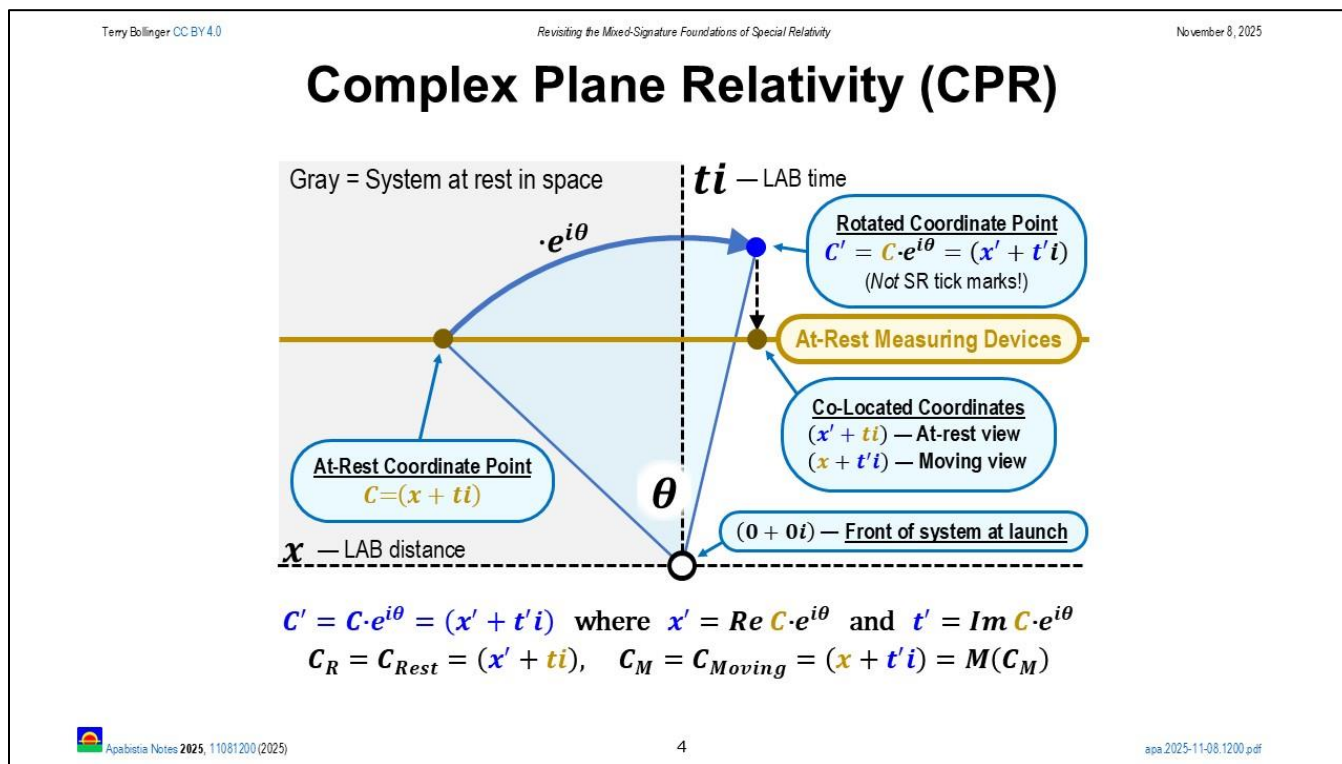
Two formalisms that I came up with [that] I'll be explaining in some detail: First one is a tilted block formalism. This one was... this was fun. This is... you know... you have the thing where you have a *genuine* eureka moment where you just go like "I didn't expect that" and you go like "How did that happen?" and this really was one of those, because I was going through some of the math on how the transformations work, *if* you take into account the *disparity* of clocks... If a train is moving you'll have non-simultaneity on those clocks. If you formalize that, put specific math to it, and then carry that on into a space-time that's Euclidean, you wind up with these very stable structures, and those structures in turn can be used to predict, in a very intuitive fashion, the transformations of special relativity.

So, the tilted block formalism, I... It was a surprise and a *nicely* intuitive surprise. You can literally teach this to grade school kids and show them how to do it and it's *not* a difficult transformation to use. So it's nice just in terms of... It always surprises people who say "Well that can't possibly work!". Well, you have to actually *try it* and then you realize, well, yeah, it *does* work and then you can go through the math, which I will, to explain why it works that way, but the more... I think even *more* interesting one that *really* had me wondering what was going on is that if you take the tilted block formalism and then reduce it to its minimal steps mathematically you wind up with a rotation. The rotation is best interp—... is best represented as a quantum-like phase rotation. That is, you take the e^i exponential type format... You can do this with matrices also, but... This just points out the similarity and that pretty much covers it. So you wind up with special relativity coming down to a multiplication of two complex numbers.

That's unexpected. That's not what you would expect if Euclidean was the worst way to do special relativity. Instead, you take a Euclidean space *without a mixed signature* and the opposite happens. The structure collapses to an extremely simple form, which I will now...



[7:39] ... show you.



[7:42] This is the rotation in the complex plane, and all it is is taking a point on the left, which represents some point in the time history of an object, of a potentially very *large* object... which is often skipped in special relativity... You've got to, like, accommodate the large objects... So you take a point on that object, you rotate it,



which is multiplication, by $e^{i\theta}$ (green angle, theta can go up to 90 degrees) and you wind up with a *new* location that gives you *new* information.

Your Lorentz compression, your time dilation, your location in real space, your settings on the clock that you will see as you see this person go by at a high speed, your own clock settings. everything that you need to know about that system (you can also estimate the energy, because you will have the Lorentz factor)... all of it just pops out, and *that's* a remarkable thing. One of the key issues that you have to accommodate and this is where I say Minkowski representation does not address acceleration well. The only way you get this simplified rotation is if you look at the *front* of the object that you were accelerating and treat that as a *very special point*. That is the point at which all these rotations begin, and by doing so you also *attached* that rotation to that point in space. There's a coordinate system lockdown that occurs when you do these rotations.

So... *unexpected*. Unexpected, deeply interesting, and also presents possibilities for mathematical connections, *especially* to quantum mechanics. In a sense, this is saying that... you know... special relativity is a large-scale version of the same kind of phase rotations we see at the microscopic scale in atomic particle physics. It has a limited range, but yet it uses the same kind of concepts. *That's* intriguing, because you could be looking at a thing where concepts of acceleration and rotation are more closely related to quantum than we would have expected.

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A Few Implications of Complex Plane Relativity

- Inertial frame coordinates exist only in hierarchies
 - Inertial frames form in hierarchies centered on rotation points
 - Every new subframe *retains* the coordinates of its ancestor frame; its own values are only functions of those coordinates
 - Focusing *only* on identical physics within each frame ignores this important frame hierarchy
- Poincaré (and Lorentz) symmetries are local-only
 - These symmetries exist *only when created* by matter systems
 - The belief that symmetries exist *independently* of measuring devices creates an *illusion of universal spacetime*

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[10:08] Some of the con—... Some of the implications *from that formalism I just showed*...and again, I'm giving the conclusion first intentionally... Once you acknowledge that you have to put coordinate systems attached to the front point of an object which is being rotated, or otherwise you wind up with nonsensical results (you wind up with false histories and things that don't make sense)... but once you *do* that, once you attach it there, everything falls into a hierarchy, because each time you have an acceleration of an object you create a new coordinate system that has a *very* specific and a very... one-for-one relationship to the *previous* coordinate system.

That is *not* what they say when you talk about everything being... you know... absolutely identical. It's true that the physics is identical *inside of the frame*, but what you have to look at and what you *have* to take into account is

that in the process of creating that frame (that new frame) you have to attach it to the coordinate system of the earlier system, and that one is a much larger system.

So this is a *very* different view of inertial frames that is actually *more* in keeping with our intuition. Our intuition is that an accelerating spacecraft is *not* identical to the rest of the universe, because you put an *enormous* amount of energy into it. It's an excited state of that matter.

This hierarchy of space that you get with these coordinates *really* emphasizes that and really focuses in on that same point. [It] says that yeah, you have to treat this as a *subset* of that larger hierarchy. The spaceship, even though it is accelerating... you think it has internal physics that are what you expect.... with... if you could not tell the difference, that's... that remains the same... the Poincaré symmetries... but at the same time it is firmly embedded *still* in that larger space and that has all sorts of implications, many of which actually wind up resolving issues like twin paradoxes much more easily.

So, the identical physics is actually one of the most fascinating things, because if the physics is *identical* inside of the spaceship and yet the spaceship is essentially a little tiny subset of some much *larger* set of physics then what does that say about the concept of space and time within that spaceship? It says that you are *creating* small instances of space and time, but you're not actually creating *universal*... or accessing some *universal* space and time concept. You're essentially creating it by the manipulations of that matter, and again, this goes back to the idea: which comes first, matter or physics? And in this perspective, you go down this... this framework. It is *hard* not to recognize that the *nature* of the acceleration of the matter is *critically* involved with how you create the new definitions of space and time. They're not independent issues.

So, [my] last point: the illusion of universal spacetime. That's a dangerous illusion because we *never* see that experimentally. When a spaceship is accelerating across the universe the rest of the universe *does not care*. The rest of the universe *does not see* its definition of space and time, because the speed of light alone prevents that from happening. So, you want to be careful in the mathematics that we don't have an illusion of universal spacetime that has no correspondence to actual physics.

Assumptions in this Presentation

- **Einstein got it right (but with a few very subtle math errors)**
 - Every inertial frame has **identical physics** to every other inertial frame
 - No cheating by excluding extreme energies (no "**ultraviolet cut-offs**")
- **Only direct contact** fully resolves the relative timing of events
 - **Distance** between entities *always* introduces **space-time ambiguity**
 - Only direct contacts can **irreversibly remove** such ambiguities
- Fine-grained, observer-owned **clouds of clocks** (from Einstein's *The Theory of Relativity*, 1911) **fully resolve complicated cases**
 - Einstein invented and first used clouds of clocks to **predict time dilation**
 - Fine-grained clouds give the observer a **fully Euclidean** interpretation (!)
- **Almost-instantaneous acceleration** is always feasible (muons)



[\[13:47\]](#) Assumptions in this presentation...

I love... I... again, I... Going through Einstein's papers... They're just marvelous. He... His way of thinking is very... not surprisingly, very different from most approaches to these problems. He seemed to *think* in terms of physics, not so much visually, but he just was like a *human emulator* of physics. Nonetheless, he did... and I've talked... he did make some subtle math errors (I've talked about these before) and they had to do mostly with these coordinate point issues I've already mentioned.

The idea that you have to have a very specific point in a material system that is defined as the zero point of that system... That *seems* like such a harmless, innocent thing to say that it doesn't matter, which is what Einstein did, but it *does* matter and in fact you get all sorts of paradoxes if you don't pay careful attention to this. Einstein was adamant that *any* frame at *any* energy has identical physics and that is exactly what we've seen, to the *nth* degree, in experiments of gamma rays.

It doesn't matter how fast you're going, you see the same physics. Ironically, ever since the time of Einstein, people have tended to go back, right back to the classical type of viewpoint that "Well... you know... actually, space-time must have some kind of granularity. Actually, there must be some ultraviolet cutoff point where the energies can't handle that."... and that's *not* what *he* was saying and experimentally it still turns out to be true that it doesn't matter how fast you accelerate, how fast you're moving: you still see the same physics.

If you read some descriptions of special relativity you'll get these issues about how... you know... There's always this space-time ambiguity and people focus on *that*, and there's a certain danger in focusing on the ambiguity. It's fun, it's entertaining, it can come up with all sorts of mysteries where you say, like "Well, we don't know if it really happened."... but the *actual blunter* truth is that to *derive* the concept of a twin paradox... When Einstein first said that this... that "Hey, this time dilation thing is *real*, you can actually *measure* it."... The way he *did* it was he used direct *contact*, which is always available.

So you have a laboratory, you have little tiny clocks everywhere, which essentially (in like, for instance, a cloud chamber) that's what you're doing, because every bubble that you form is essentially *attached* to your definition of what time is. So you can *time* when that bubble forms and you can *time* what the implications of it are. All of that can be measured in the observer frame.

So this was the approach he went [with], [it's that] he focused not on the space-time ambiguity, which you *must* take into *account*, but he focused on saying, like "Well how do I *remove* that ambiguity?"... and Einstein came up with this idea of having these sets of synchronized clocks over a large area and said *very specifically* that until you do this you cannot make a physics measurement, which I thought was a remarkable statement. He said that *this* is how you *resolve* the ambiguity of what it means to be at a *certain* location at a *certain* time in a *certain* space, and so I thought that was a *marvelous* idea he had with this idea of clouds of clocks that have been synchronized, and then he went off in another... and then he went off in another direction for a *fascinating* bit of history that, again, I've talked about some other times.

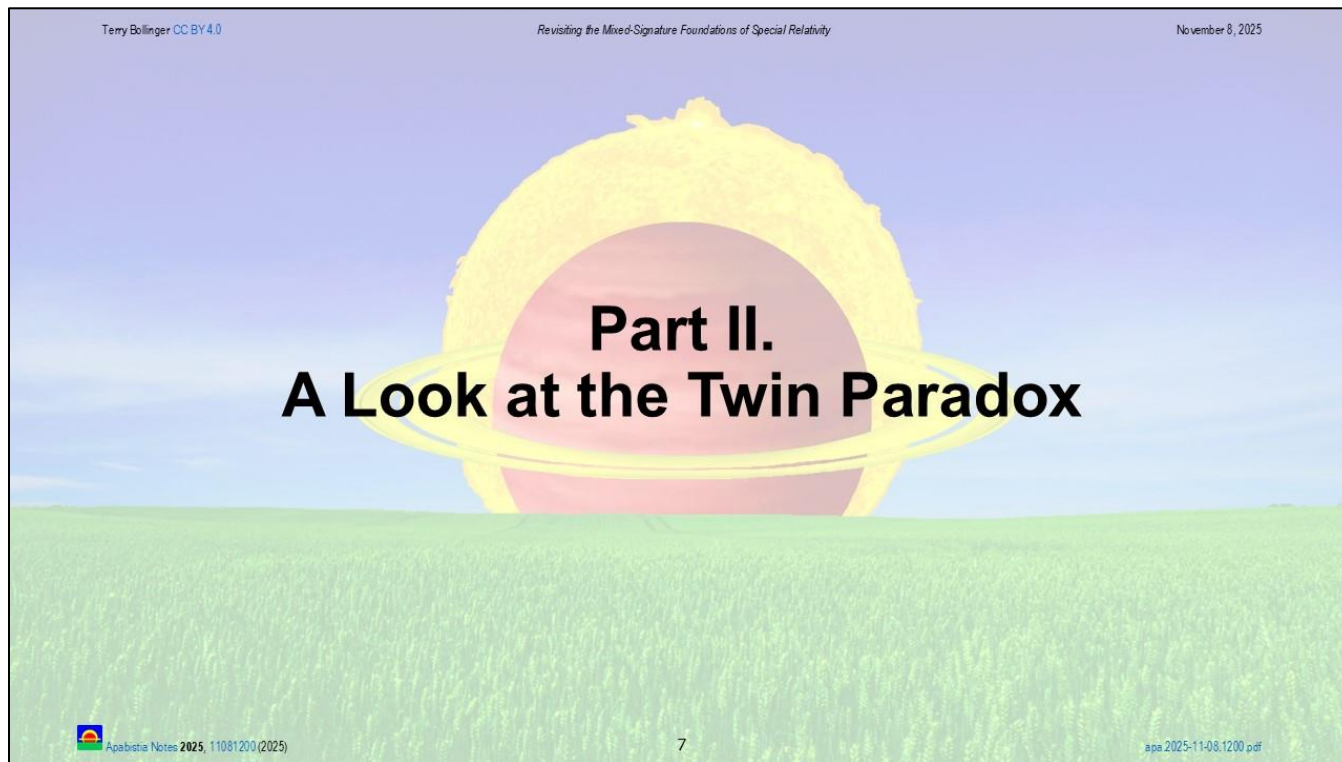
So, you have the prediction. Fine-grained clouds, these... The other thing I want to emphasize is when you *use* Einstein's technique of doing these clouds there is no *mixed* signature, there is no *negative* time, there is no... there's no definition of it that you *need* a more *complicated* form of space-time to take care of it. It's fully Euclidean. You're simply saying: Here's a bunch of clocks. Here's time going this way, and it's four-dimensional, but you can just *ignore* one or two dimensions and you wind up having something that's very, very understandable, and it's just classic square Euclidean (as they would call it) geometry. Everything's orthogonal. So, that *is* an early instance of a fully Euclidean interpretation of Einstein's special relativity, *done by Einstein* no less. So, it's not *emphasized* that way, but it's important because that's the way it winds up doing it.

Now, the fast... The last little point here that I'm making is important just because if you want to take the infinite approximation of how acceleration works you need to know what's possible, and it is always possible at the



particle level to do an acceleration that, as far as we can tell, is almost instantaneous. It's actually an interesting little question. I'm sure there are papers on it, about how much time does it take, for instance, for an electron to be accelerated, to be *emitted* by a nucleus.

So, there must be *some* kind of a time on it and it's a difficult issue to measure, but things can go *very* close to the speed of light in a *very* short time and that's important for the mathematical models that I'll be presenting. The fact that you can *go* to that limit says that this is something that you can calculate and then see what the effects of it are. So it gives you an opportunity to *look* at the full range of *behaviors* that result from instantaneous acceleration.



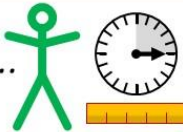
[\[19:27\]](#) A Look at the Twin Paradox...

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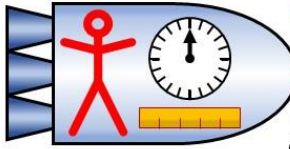
Special Relativity Says: Speed Affects Clocks & Rulers



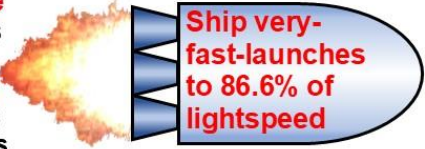
Alex
uses
Earth (distance and time)
clocks
& rulers



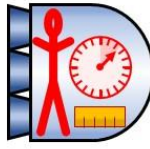
Distant, unmoving
Beth also uses
"Alex Standard"
clocks & rulers



Charlie
begins
with
Alex's
clocks
& rulers



Ship very-
fast-launches
to 86.6% of
lightspeed



On his arrival,
Beth measures
Charlie's clocks
as slower & his
rulers as shorter

- If an object moves fast, special relativity says its:
 - **Clocks tick slower**, and
 - **Rulers are shorter** in the direction of motion
- At **86.6%** of lightspeed ($0.866 c$), both are **half their original values**

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[19:30] Okay. This is going to... Simpler, quicker, let's just talk about it: How does spatial relativity go? This is intended for... If you're not very familiar with the twin paradox, this is intended to be a fairly easy explanation of how that works.

You've got Alex back on Earth, he's got clocks and rulers, you've got somebody over at *another* location who *also* has clocks and rulers that are showing a different time... showing the same kind of time, that he's on the same kind of acceleration. You've got another fellow, Charlie, in a spaceship here. He launches and we're going to assume *very fast* acceleration so we can just kind of *ignore* the issue about how does the energy get put in there. Just *assume* that it's very fast. We're going to focus on the *speed*.

So, you have this launch. He launches at fast speed and arrives at another location, and Beth, on the right side, measures his clocks and sees that his time has gone more slowly, and that his rulers seem to be shorter as they go by. Lorentz contraction is *not* a vague thing. If you're actually instrumenting the space *in detail* and you look at it, so every point has a measurement... This is something Einstein went through in *great detail* to *derive* this concept... There's an actual contraction. That ship *has* to be shorter and not just in an abstract way. It fits within a much narrower boundary.

So, Beth at the other end will see Charlie's clocks as actually being both slower (they only, in this case, had *half* the time on the clocks) and his ship is half the length of what it was before. So, I always like to pick on 86.6% of light speed, because that's a convenient one where everything is one half. So, the clocks tick half as fast, the rulers are half as long and you get these... both of these effects of the Lorentz contraction. All of this is *incredibly well proven*, so for... you know... if you're not familiar with that and it seems strange and you go, like "How did that happen?"... Experimentally, this is just what we see. You can see it in *all* sorts of different measurements. The time dilation is just *integral* to every aspect of particle physics. The contractions of the field, again: integral to every part of physics. So these are not... These were once predictions, but in the centuries that followed since then they're *very, very well proven*.

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Vast Regions Can Share Similar Clocks & Rulers



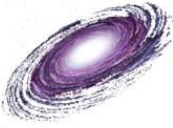
Alex










- Clocks and rulers that **move slowly relative to Alex remain similar**
- Distance makes no difference. **Only relative velocity counts.**
- This means **Earth's "rest frame"** of similar clocks and rulers is **enormous**, including **planets**, **stars**, and even **distant galaxies**

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[22:00] Now, *this* is a point that *does* get missed and I really want to emphasize this. [It's] what does it mean to say that you're in *the same inertial frame*? That is, you have the same definitions of clocks and time and how time passes, and the point is this: The *distance* doesn't matter. What does matter is whether that distant object is *moving relative to you*.

So if you're on Earth, and again, I'm talking about velocities where the speed of the Earth around the Sun, even the speed of an entire star, are *relatively small*. They're considered *insignificant* compared to special relativity. Compared to the speed of light, these are *barely moving* type situations. So then you say "What is the *range* over which my definition of an inertial frame is valid?"... and if you're not careful you can underestimate that very easily, because you can go all the way up to the Andromeda Galaxy, for instance, in our local cluster. It's actually moving *towards* us.

So you can find stars and globular clusters that are in the same inertia frame that *you* are. You can tell that they're not moving relative to you. You can figure that out with your telescopes, and then you go like "Oh, if anybody's on that distant planet and that distant star in another galaxy, they've got the same clocks I do. They have the same measurements of time that I do, give or take a little bit." So you can *know* that if you could send a signal all the way out there and get a signal back, you would wind up saying that "Yeah, we watch the same amount of time pass. If we measure something, we *will* see the same amount." So, if you take this into account, certain frames are absolutely *enormous* in size, because distance is not the important criteria, *relative motion* is the important criteria. So this is one that you want to take into account. This turns out to be surprisingly important for understanding some of the issues about why you get things like the twin paradox.

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Fast Spaceships Have Unique Clocks and Rulers

- Clocks & rulers on Charlie's fast-moving ship **disagree** with Alex-standard ones
- When Charlie's clock **passes an Alex-standard clock**, the Alex-standard clock always measures an **increasing loss of time for Charlie** (relativity is lost)
- Einstein used clock comparisons (*not* acceleration) to **predict time dilation**

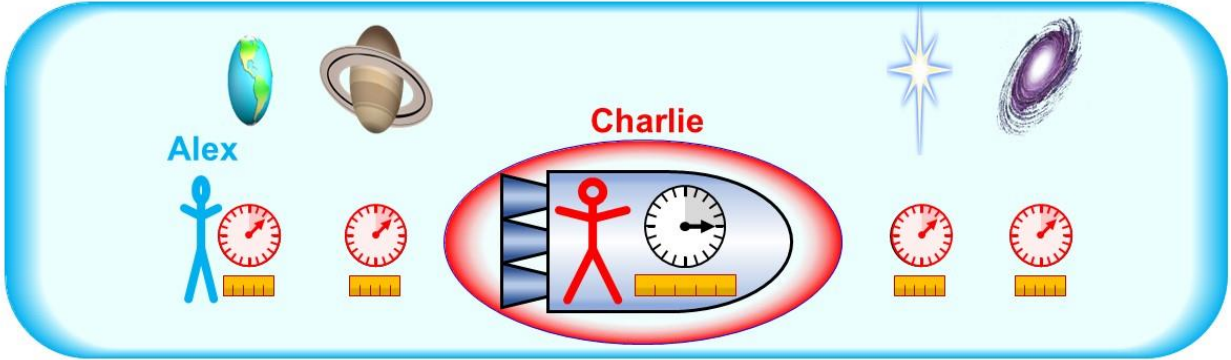
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[24:11] Fast spaceships, in contrast, as I mentioned earlier, have unique clocks and rulers. You've got this case here where Charlie, he's going off, and you got him accelerated at this very high speed, and that must have been a fun launch, to go 86.6% of light speed and do that in just a fraction of a second, but assuming he survives the acceleration, what you... what *anyone* sees as Charlie goes by... This is the important point about how this frame is so huge. You *cannot* get around the prediction that every person, no matter how far away, even if they're in the Orion Galaxy — Orion Galaxy, oops, that's a new one! The *Andromeda Galaxy* [was what I intended] — they will see exactly the same effect on Charlie. They'll see Charlie squashed. They'll see Charlie having slow time, and they'll *all* be in agreement. It may take *a million years* to get the report back so you can share the consensus, but it really doesn't matter. You can estimate it on smaller scales and you can come out with the same one.

So you have this really *marvelous* metrical agreement across an *enormous* region of space and they *all* say the same thing. *Charlie* got squeezed. So, that's not relative. That part of it stays the same for *each* of these observers. This is, in fact, again, how Einstein derived the twin paradox... The fact that time dilation is experimentally accessible... This is how Einstein derived this idea, by *looking* at these clocks over a *huge* area.

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So Where Is the Paradox?



- **We're not done yet!** Special relativity also says: **Charlie's clocks and rulers are as "fundamental" as those of any outside observer**
- This means **Charlie should also measure time losses & shorter rulers** when viewing Alex's clocks & rulers, no matter where they reside in the universe
- This symmetry between Alex and Charlie is called the **Poincaré Symmetry**

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[25:53] Now, the obvious thing to say after this is *so where's the paradox?* Why is the twin paradox a paradox? Because, okay, so... you know... he slows down, he *shortens*. So... you know... you could do that by *other* methods. You could *squeeze* satellites together. You could *slow down* the clocks. You know... those are very mundane ways in which you could see the same effect. Here's the catch and here's the part that makes people kind of go around in loops on how they interpret this: The assertion that the space *inside* of Charlie's spaceship is *absolutely* as good as anybody else's space has an implication that you *can't* get around, which is that if everybody else sees *him* as squashed because he's going at high speed, *he* should see everyone else as squashed and going slower because of the high speed.

You've all heard this paradox. Anyone who's bumped into special relativity hears this thing about "Well, how can both sides see the other as going slower?"... and you go round and round on this whole issue. So, this prediction comes from... not from... [not] directly from Einstein's argument, but it comes from the application of a symmetry, and what it is (the symmetry) is this: It says if *your space* is absolutely the same it should *apply* universally. The Poincaré symmetry should apply to the *entire universe*, so that what he sees inside his ship should also apply outside, and *that's* where your paradox comes from. You say like "Well, this symmetry says that these... Every space is identical and every space is fundamental, then you should have *this*."

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Poincaré Confirmed! Visiting Muons Decay Slower

- All experiments done inside the ship confirm Poincaré!
- VISITOR muons (“particle clocks”) from outside decay at **0.5 the rate** of motionless muons created inside the ship (SHIP muons)

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[27:40] Now, is that true experimentally? Yes. Man, this is... I love this part. *Why* is it true experimentally? Because if you are in a fast spaceship (and there's ways you can imitate this situation, you can *emulate* this situation) and you're hauling through some space and a muon comes in from the front portal of your ship and you measure that muon... (The muon's coming from the outside universe, so it was just created at rest in the outside universe)... you *measure* that muon, what you find is that it is delayed by exactly the amount you expected. It's slowed down in time. It lasts longer. It leaves a longer path, and you say "Ah, it was exactly right." Poincaré, Lorentz, Einstein... They were all right on this point. There's a symmetry that when *I* look at the outside universe, I see *exactly* the same result that the outside universe sees when they're looking at *me*, because you see that you have this time dilation effect, so you kind of... you know... you can kind of applaud a little bit and say "Cool! We've proved that this is true."... and then you have this... you know... this sound of one hand clapping type of paradox. It's *really* fun to contemplate.

That's one of the reasons why this gets so much attention. [It's that it's] *fun* to have that kind of a paradox in your head. You say, like "Well... Oh, I've just proved that the muons from outside decay more slowly."... and you say, but I also proved that they see *my* muons prove... decay more slowly. So, it's a *fun* sort of thing to play around with in your head. There's just *one little problem*...

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Poincaré Contradicted! Muons in Front Decay Faster

- Forward observations **contradict Poincaré**
- Muons in front of the ship (FRONT muons) **decay at 3.732 times the rate** of SHIP muons (almost 4 times faster)

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[29:25] ... which is that if you look more *carefully* it's only true inside your spaceship, which is weird. You say, like "Well, wait a minute... Wait, what?". Yeah, if you look *in front of* your spaceship you *don't* see this effect. You see the muons decaying *very, very* quickly are very... Yeah, they're just... They're gone. So you say, like "Wait, wait a minute, that's a"... you know... This is nicely paradoxical. When it's *inside* your ship it goes slower. When it's *in front* of your ship you see it decaying *faster* (?), and you say "How did *that* happen?". In fact, it's not a *small* amount either, it's almost *four times faster*. So it's considerably larger than the Lorentz factor. So, you go like "*What* is going on with this?"

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Poincaré Contradicted! Muons in Back Decay Slower

- Backward observations also **contradict Poincaré**
- Muons behind the ship (BACK muons) **decay at 0.268 times the rate** of SHIP muons (almost 4 times slower)

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[30:12] So you take your telescope, you look around, and you say “Well, let’s check out the other direction.”. *Whoops!* This is even weirder, because if you look behind your ship, and you find a muon back there and you look for the decay properties you say that “Yeah, in this population of muons *behind* my ship they’re actually decaying *slower!*”. So... and not just by a *small* amount, but they’re decaying, like, by one fourth the rate that they should be decaying at. They’re lasting *much longer* than they should be. So, you got faster in front, you got slower behind, and inside your ship they’re slower, but by a different factor than the ones from behind. *What the heck is going on?*

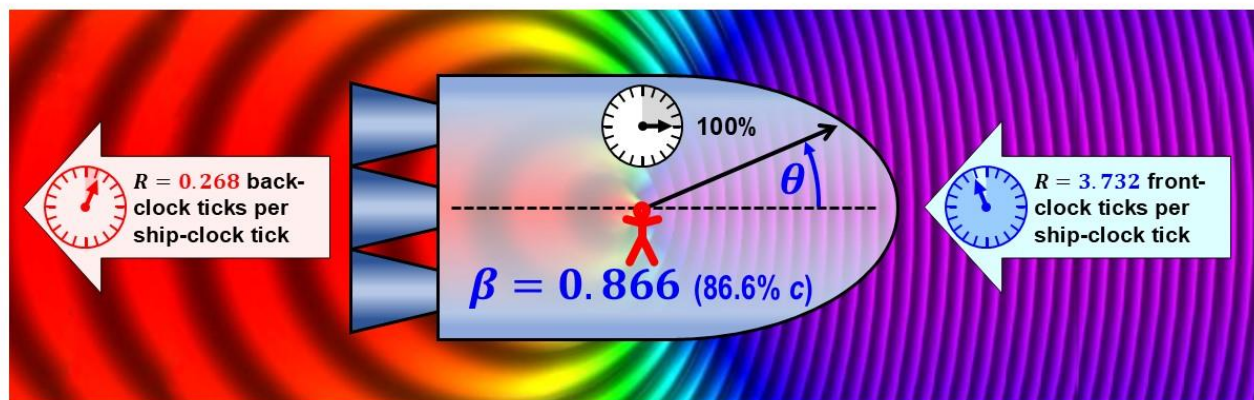
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Revisiting the Mixed-Signature Foundations of Special Relativity

November 8, 2025

What Is Going On? Think Ambulance Sirens

- Outside the ship, time follows **Relativistic Doppler rules**
- The full equation is: $R(\beta, \theta) = \sqrt{1 - \beta^2} / (1 - \beta \cos \theta)$



Relativistic Doppler background by TxAlien, CC BY-SA 3.0 (Wikimedia Commons)



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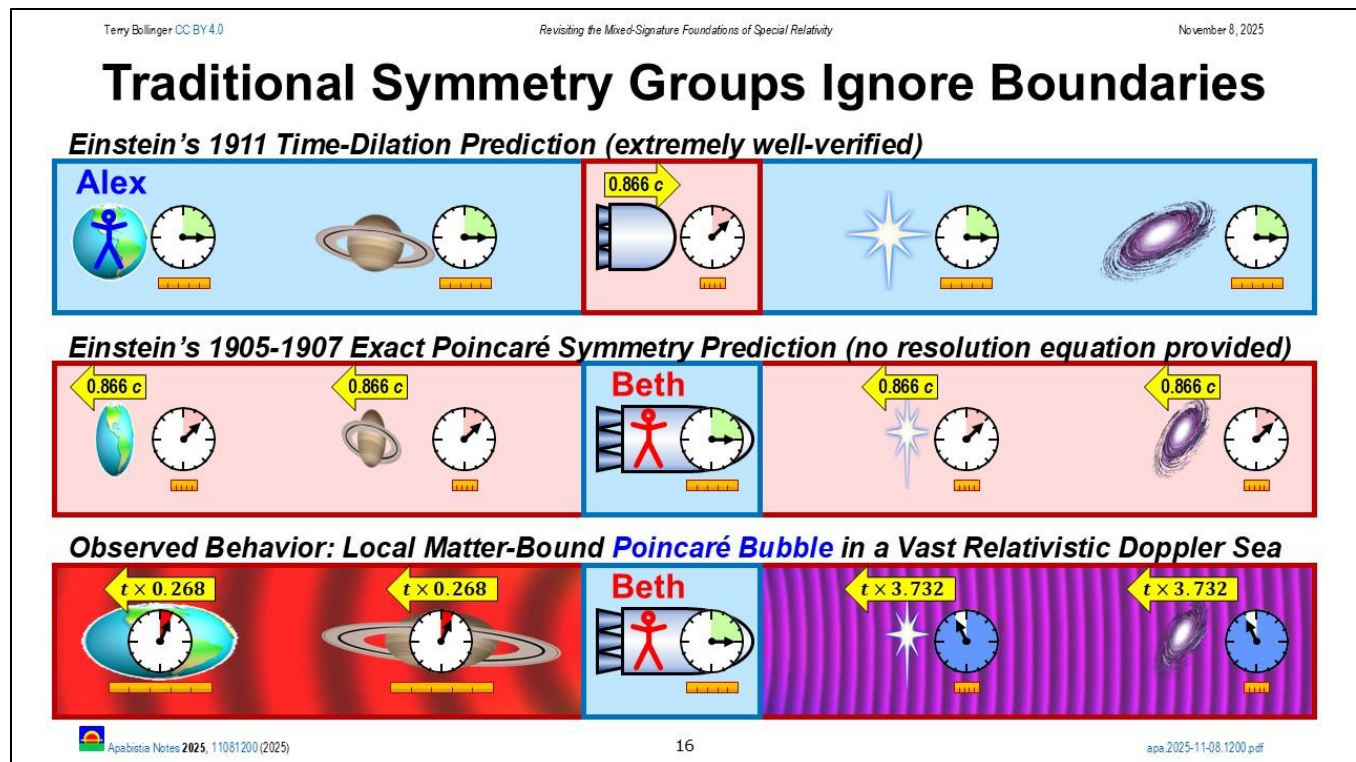
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[30:57] ... and what's going on is something called the Doppler effect.

Think ambulance sirens. You know... They go... you know... You have the beep, beep, beep, it's coming... It has a higher frequency coming *towards you*. It has a lower frequency going *behind you*. Well, the same things happen with the muon decay rate. Think of that as like a frequency. It's like a wavelength. So, you're seeing them in front, they're going [makes buzzing noise] much faster, because you're moving *towards* it. You're *plowing* through the muons very quickly and you're seeing them go in at a higher rate, and you see the muons *behind* and same thing.

Once the ambulance passes, you hear a *slower* sound, you hear a *slower* beep that's going on with that. So, you look at that... and people had to face this, I think it was back in the 70s or the 80s, when they started looking at cosmic jets. They got dumbfounded by just this point. All of a sudden, they were seeing these *disparities* about the decay time of how these things... what *happened* to these things?





[31:56] So, what does that mean *for the spaceship*? Okay, Einstein time dilation (very well verified), exact Poincaré symmetry... Ah, that's a little more problematic, because when you're *inside* the ship, yeah, you've got the symmetry you expected, but when you're *outside* the ship, something different happens, but you've got a set of equations for that *also*, because relativistic Doppler is *also* nicely quantified and has its own set of rules.

So, what you wind up with is this: Inside of the ship, you have a bubble of interpretations, and you can go into great detail on why this happens (actually, it's very fascinating why it happens; there's some interesting geometries) but you can go inside the bubble and *in that set of coordinates* in which everything that is... The clocks of the ship apply, the rulers of the ship apply. You get the expected prediction of Poincaré symmetry. *Outside of that* you have this relativistic Doppler sea, which is *enormous*, it's the entire universe, and you also recognize that it's really... The reason this is happening is because you're just *looking at it*. You're just reading the data differently. You're not *changing* the outside universe. You're just reading data at a faster rate in one direction and slower in another direction. In one sense, it's *very mundane*.

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But Terry, This is Just Blueshift, Not Time! Right?

- **Nope.** What light encodes **cannot be forgotten**; it becomes history.
- On arrival, **the final clock must match the individual speedups**

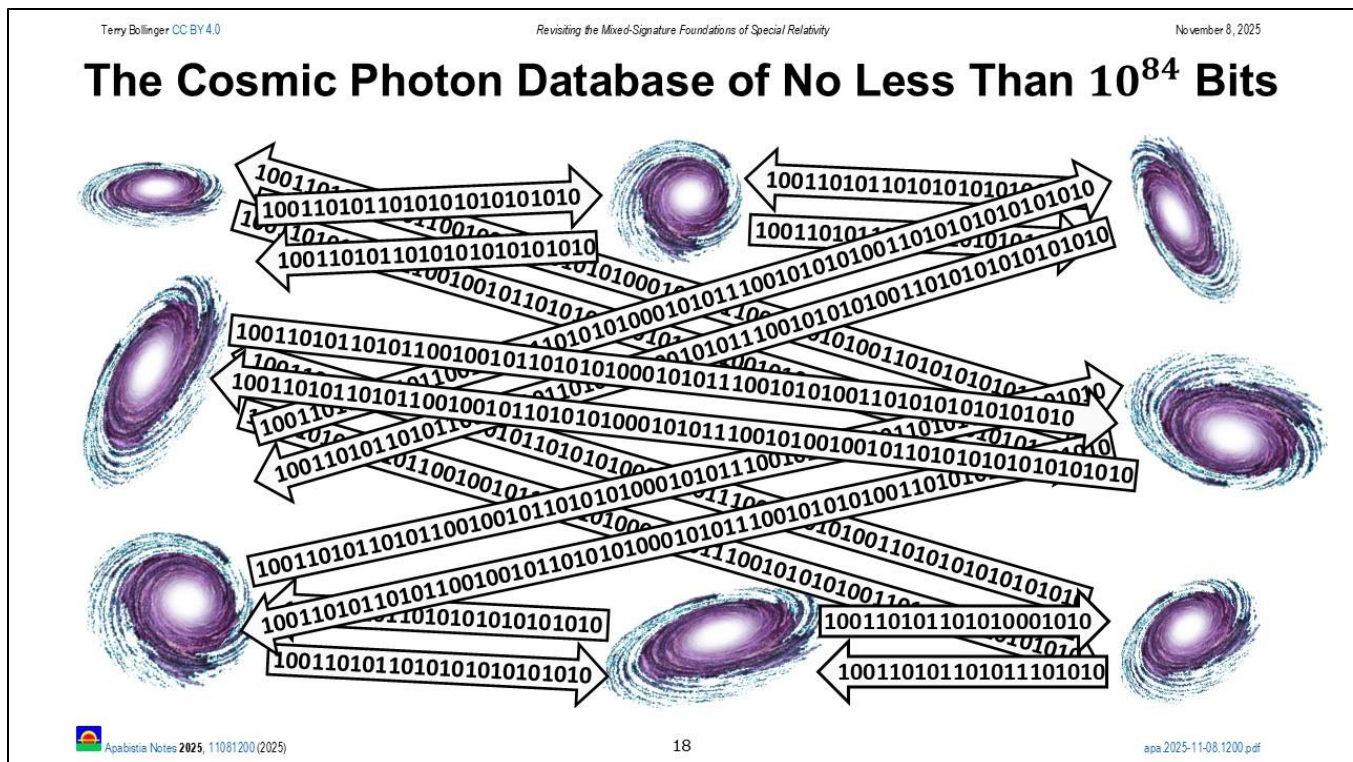
Adding individual speed-ups along the path requires the destination clock to match

Andromeda Destination

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[33:26] Now, what you *might* be asking, maybe what you *should* be asking is: “Yeah, but that’s just blue shift of light, right? Doppler blue shift and... you know... ambulance sirens, the same idea. You got this blue shift.”... but it’s *trickier* than that, because you have a lot of information encoded onto that blue shift. If you have circular polarized light, as the light actually rotates, it *is* a clock, and you actually see the clock of the circular polarization, you see the phase, the frequency changing faster.

So this is something where you *want* to be a little careful about where... you know... *how* you look at this issue of blue shift as it being *just* an issue of light. It’s not. It deals with time itself, and for some reason my slides are not moving...



[34:24] There we go! Not sure what happened there. It was not responding.

This may be a concept that's new, but it's *well worth considering*, because when we talk about empty space we treat it as if it's completely empty. *That's* not the case. If you look at the universe around you, every empty... you know... *relatively* empty bit of space, has an *enormous* number of photons, an *enormous* number of neutrinos also, passing through it all the time, and these things take... years? Minutes? Years? Decades? Millions of years? Billions of years?... for that light to pass [through that] full distance. *That* is a memory storage device.

Do you ever think of empty space as a memory storage device? You *should*, because when it's full of light, the light is a queue of information that once it's there it doesn't disappear. Now you can get into abstract arguments and say "Well... you know... it depends on the final resolution.", but experimentally this is what we see. Space is full of information. That's why you can go out in distant space and you can see distant... old events from a billion years ago, because they're stored in this database, this cosmic photon database.

So, *contrary* to the... your feeling that empty space... you know... is just something you can *sail* on through with no problem, if you look realistically, especially from a quantum mechanical viewpoint, [it's]... Are you going through empty space? Are you going through an absolute *cloud* of information, that has all sorts of specificity about things that happened a long time ago, and once these things happen and are recorded, this database...

Causality Implications of the Cosmic Photon Database

- Once light is emitted into the vacuum, history has been created
- It *does not matter* whether you have seen the data yet
 - The photon data is now stored in the cosmic photon database (CPD)
 - The CPD behaves as an observer of that past
 - Ironically, quantum uncertainty only impacts *where* that data finally lands
- Alternatives:
 - You can invoke a “universal quantum wave function” and assert none of this is happening until an observer “sees” the photons
 - The result is philosophical, not observational; *we only observe in time*



[36:12] ... really does behave as an observer. You can, and again... You can get into these interesting things, you can talk about a universal wave function, and nothing really exists until it's finally observed in that, but let's stick to the experimental side of it, of what we actually see with real instruments, like Einstein talked about, because if you go in that other route you'll never get any resolution.

You have to pull it back to saying “What do I actually see when I use an equipment in time that I can access over lengths and distances that I can access?”. What you see in that thing is that this cosmic photon database is an observer. It solidifies the existence of these distant objects. So if you know there's a galaxy, like Andromeda, which we see, we know that the light is delayed. We know it's taken a long time to get here, and that's not the issue, but if you assume there's some cont—... a decent level of continuity to the universe, which we generally do, we can say “Well, it's probably still there and it's probably still doing that.”, and if it is it means that the entire space in between us and the Andromeda Galaxy is absolutely packed with data, just an enormous amount of data.

That 10^{84} ... That's a big number and that's just the *lower* end of it. I mean that's not even *close* to what it actually has. We don't *know* the total amount of data that is stored by light and neutrinos in empty space, but it is absolutely... It's one of those rare cases where we can say 10 to the 100th and actually have some meaning to the expression, because that's the kind of ranges you're getting into with this and in a universe where quantum information is important that makes a difference.

So, you want to be careful about... you know... *not* taking this existing data into account when you try to understand what's real and what is not real. Incidentally, I'll point out one interesting thing I just find fascinating: We talk about quantum uncertainty of a photon. You *have* to be careful about what that means. The quantum uncertainty is *not* the information that the photon encodes. The quantum uncertainty is *where* that information will land.

So you can have one photon that's emitted from a star and its wave function will expand enormously and could land anywhere in the universe, but when it lands it still has the same bit of information, it's just that you don't know where it's going to land. So, quantum uncertainty does not mean absence of information. Quantum uncertainty means absence of knowing who's going to *get* the information. It's a very different thing.



Once you have the information in the photon... and again... you can go through theory and say “Well, I just... I don’t like that. It’s gonna make it all uncertain.”, but experimentally, come on. This is what we actually see. You don’t know where it’s going to land, but you know that when it lands you will get an image that will tell you something about that distant object.

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November 8, 2025

Resolution: There Are Two Symmetries in Play

The Poincaré symmetries only apply inside a **constructed** Poincaré “bubble” that moves through a **vastly larger** **interpretive** symmetry space

Poincaré Bubbles
(PBs) emerge *after* manually **altering** components. Only cooperating items “see” this “isotropic” symmetry.



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

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[39:14] So, this is... Hitting that point again, the resolution is you that have two symmetries in play: You have a relativistic Doppler universe that is *only* interpretive. You’re reading the database. You’re reading the cosmic photon database, and whatever you do with it is entirely up to you. You’re interpreting it the way you want to, but you’re not *changing* it. You’re not changing the way the universe works. You’re not changing the causality that happened a billion years ago in the Andromeda... Well, that would be too close... in some distant galaxy... That just happened. That data’s already out there. That train’s long gone.

So, relativistic Doppler is an *interpretive* symmetry. It just says how you... how you process what’s going on. The Poincaré bubble though, *that’s* a whole different ballpark and that is fascinating, because the fact that you can create a bubble of interpretation inside that spaceship that says “Here’s how *I* see space, time, the direction of time, the measurements of space, the definition of a particle, the idea of what is a point particle, and what isn’t. I can control *all* of that inside my spaceship.”. That to me is actually *more* remarkable than the idea that that’s some universal symmetry that applies everywhere, because it ties the idea of space and time very *tightly* to the configuration and the nature of that spaceship and *that* is fascinating and it also is a path by which you can start looking at space and time in a *whole* different way, in making it an actual experimental topic.

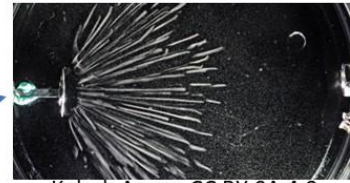
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Revisiting the Mixed-Signature Foundations of Special Relativity

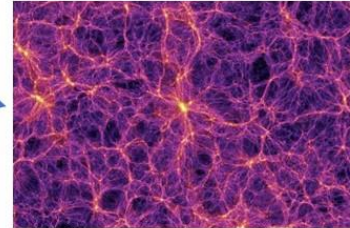
November 8, 2025

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.)
- 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).



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[40:56] Now, if you’re talking about these *bubbles*, I’ve already mentioned that... you know... if you have a *lot* of stars that are not moving relative to you, they’re part of your inertial frame, and in the terminology I just used it means they’re part of your Poincaré bubble. You have all the Poincaré symmetries for you... apply *also* for those distant objects simply because they’re not *moving* much relative to you.

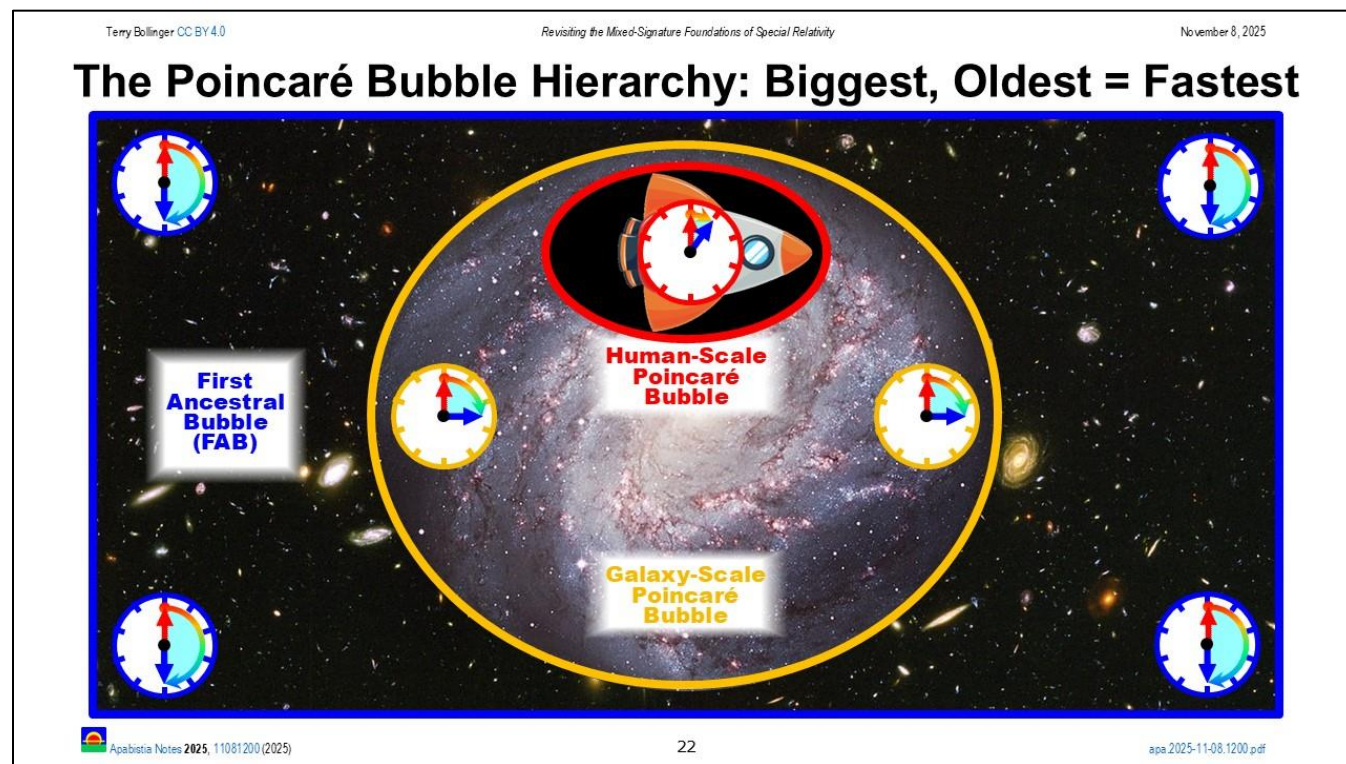
So, that already says that there’s different *sky* scales on these things. If you go down to the *smallest* scales, you have little Poincare bubbles that form about individual particles, because they instantly accelerate. Once they do that, they’re isolated from the information database of the rest of the universe in a very interesting fashion. They have their own little tiny (very tiny) world in which they have their own definitions of space and time. You go on the *other* [side of the] scale, you have these cosmic webs. Those are *fascinating* and they have some kind of relationship... I would suggest that the reason why these webs form... This has to have something to do with the dark matter, but how these definitions of space and time form would necessarily have to have an impact on the cosmic web, because if you *run out* of matter and you stretch it too thin and matter is creating your definition of space and time there’s got to be some kind of a breakpoint.

So, this is when I say there’s interesting pathways you can follow if you assume that space and time definitions are tied tightly and hierarchically to matter, then you get these interesting implications that have *not* been properly explored yet, because this is not the way we usually think of those. So, the concepts I would produce here... There’s two terms that are just handy to have... [It’s that] you have the latest ancestral bubble (Poincaré bubble), which conveniently and intentionally comes out to be LAB. In other words, your LAB bubble... The measurements you have in your LAB, not coincidentally, are your latest ancestral bubble [(LAB)], but that can be quite large, but you also go back... This is a recursive process.

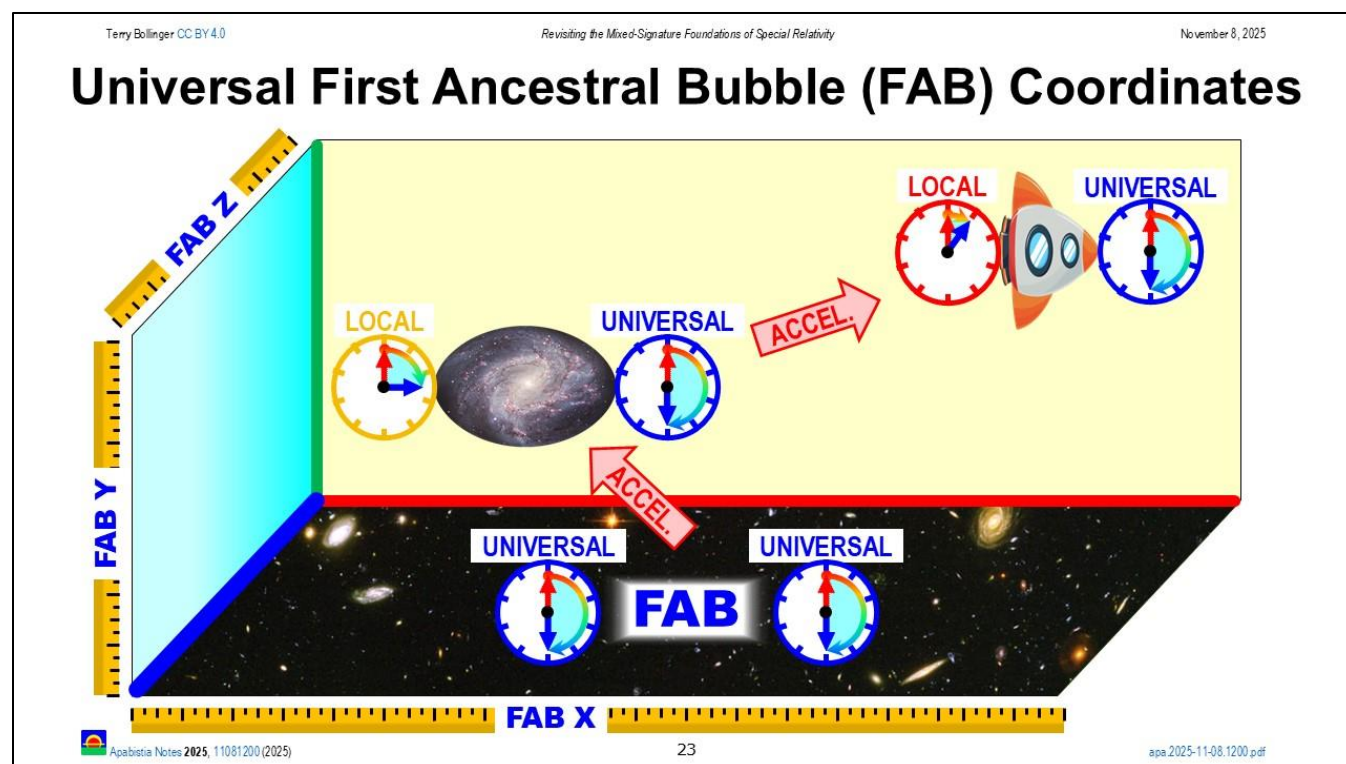
Somewhere, you go back to find this largest ancestral bubble, where everybody came from by some kind of an acceleration event. If you take accelerations into account and *don’t ignore them*, which is not something you should do in solid physics. You should pay attention to energy transfers. This... Duh. You know... If you don’t pay attention to the energy transfers, you can’t *possibly* get a full view of the universe. So, if you take all those into account, you’re going to come up with a first ancestral bubble that looks *kind of like* what we think of as the cosmic microwave background. That is, you’re going to have a general set where these things have a *shared*



definition of space and time and it gets broken up, it gets shattered, it gets manipulated, but on average, on average, you still have that kind of a fab... bubble underneath... fab as in fabrication. You're gonna find this where it's kind of built up from. So you have your fab bubble (your largest one) and you have your particular *local* one that you're using to analyze space and time (particles and events in space and time).



[44:17] Now, it looks a little bit like this. You draw that out. You get this idea of the first ancestral bubble, the idea of the *universal* level definition of space and time. Now, notice when I say this, I *am* suggesting that there is... Not just suggesting... I'm saying that if you follow this logic, if space-time is created in these bubbles, you have to be able to define, at some point, a *starting point* for this entire thing and that's your first ancestral bubble, which is roughly the idea of the universe, at least locally, kind of at rest. Cosmic microwave background... and then you get these smaller ones that deviate from that and have different scopes. So you have galaxies, you have a very fast-moving spaceship. It's gonna have its own little definition. So, this is *not* smooth space-time. This is a much more complex, richer, and really more *interesting* definition of space-time.



[45:15] So you get coordinate systems, and this... I want to emphasize *this*: The reason the idea of a fab... first ancestral bubble... is important is because *you never lose them*, and this is easy to miss in most representations of special relativity. The idea that you just can ignore where it came from is not true if the other coordinates still apply. So, what you should be thinking of is more like: Here's a set of coordinates and here's a little bubble *here* in which I have a new set of coordinates, but guess what? The old coordinates are still there. You can still have the clocks. You can still have the rulers. You can still have the particles. All those things are still there from the original.

So you don't lose those coordinates, and that's one of the reasons why you don't get time paradoxes in this stuff. [It's] because the original coordinates just say "Hey, you formed *here*. It took you this long to form and then you shot off in that direction, and I watched all of it. I watched every bit of it. I watched every microsecond of it, so don't tell me there's a time paradox, because I saw it all happen." So this *broader* viewpoint, where you get the largest Ancestral bubble that you can find, *always* resolves those issues into a Euclidean (not Minkowski)... a Euclidean format, the same Euclidean format that Einstein used to derive the time measurement, the idea that time dilation is measurable. So, you wanna keep an eye on that. Say "Oh, I can have *multiple* coordinate systems. You can literally, in that spaceship, set up clocks that will tell you exactly what the time is in the outside universe. You can always do that, even when you're watching those muons come in and decay at a slower rate.

You can always set up your own clocks to say "Yeah, but the front of my spaceship actually is moving at *this* speed, and it has *this* time setting, and the back it has *this* time setting, and lo and behold, if you go through all the math, which gets messy and also a little mind-boggling, you will find out that that *disparity* of the outside settings of your *other* set of clocks from the outside is how this whole paradox comes about. The fact that you have a time differential in your own ship allows you to see that muon as decaying more slowly, even while it looks perfectly normal to the outside universe. So, fascinating sets of relationships go on if you take this approach. Multiple coordinate systems. Not exclusive coordinate systems; that's the *wrong* way to think of this.

Why Don't Textbooks Address Poincaré Locality?

- 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-friendly Hilbert school inadvertently worsened this **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 at up to lightspeed**



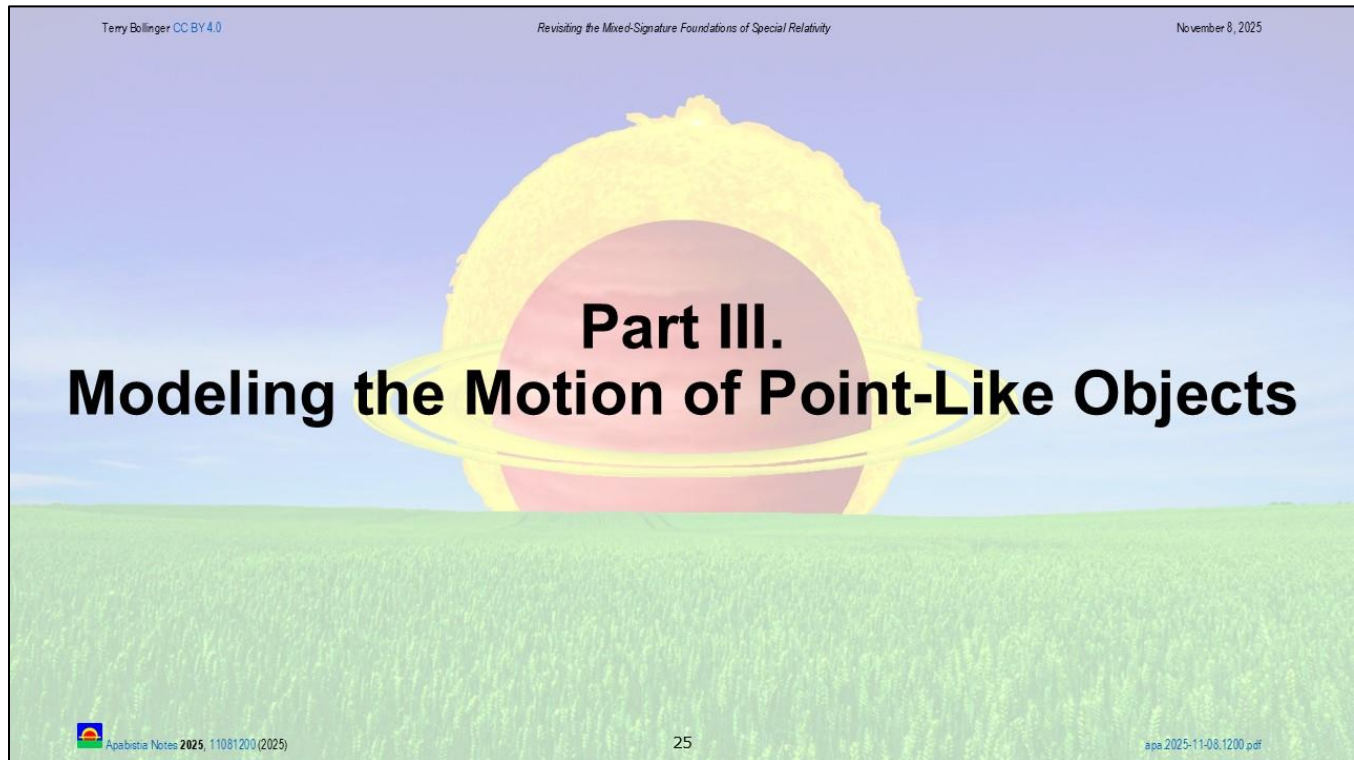
[47:50] So, why don't... and I haven't done a literature search on this lately. I am *not* aware of any special relativity textbook that addresses the idea of locality of the Poincaré symmetries, and that's unfortunate because you *need* that. If you look at issues like GPS satellites, you... It *has* to be taken into account, and what people do is they kind of... Just like with the blue shift... you know... People brush off blue shift as just light and not time, when actually *it is* time. You can do the same thing with this. These are the details of working with satellites, so you wind up with some mathematical equations that are *derived* from spatial relativity, but they're a little *wonky* in some places; you make some decisions and you wind up kind of missing the point: that there's a universal set of coordinates and *that's* really the proper way to resolve this, [it's] to go back to a *simpler* structure in which you just have multiple sets of coordinates, depending on how you set them up. It's a very computer science type of thing. If you've heard of virtual machines, this is *very* much like a virtual operating system type scenario.

That is where you have one set of software [that] sets and creates an environment for another set of software and the software inside that smaller environment *can't tell the difference*. As far as it knows, it's executing an actual physical machine, when in fact the other machine is just sitting here watching it and saying “Yeah, I see everything you're doing. I'm watch everything you're doing.” That is a very close analogy to what is happening with these inertial frame systems, because once you acknowledge the hierarchy and acknowledge the acceleration you find out that actually you were just in a little bubble. You run your own little virtual machine that was doing its own thing, and then that virtual machine could create another virtual machine, but each time it has a cost and each time it gets smaller. So, it's *not* a universal thing. It's a very hierarchical, tree-shaped type of structure.

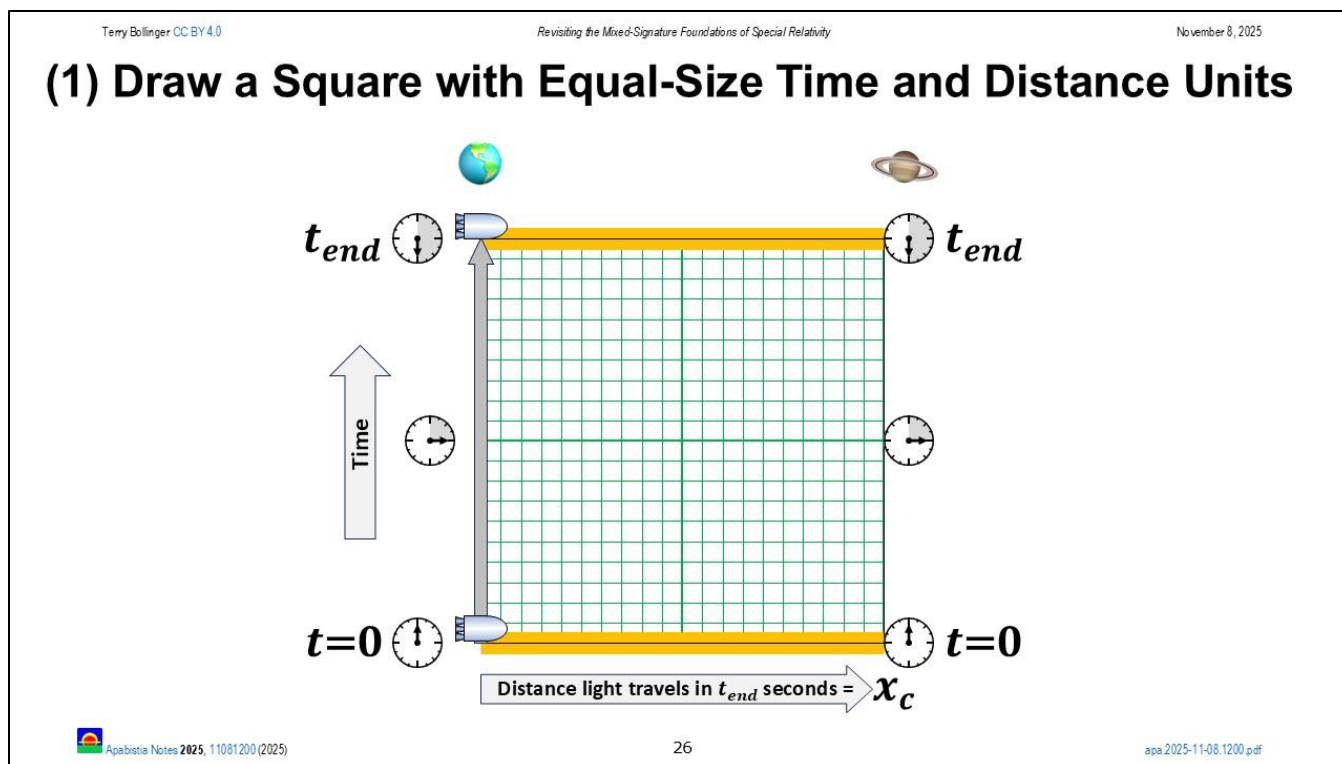
Now, the Hilbert [School]... A lot of fantastic mathematics [came] out of the Hilbert School, *but* one thing the Hilbert School does *not* do is pay attention to *distance* or pay attention to *time* or pay attention to *resources*. It just sort of assumes that if you have a nice little equation that describes some space, it sort of automatically applies everywhere, and you can do that mathematically, although even if you do it mathematically you should be careful because it is part of your axioms even if you don't acknowledge it that you have these infinite (essentially infinite) time speeds, that everything can touch itself at the same rate. You *are* making assumptions, and the excuses say “Well, the mathematics... It doesn't matter.”, but it does because if you don't acknowledge where you're using infinite ranges... For one thing, it's very hard to apply it to physics without inadvertently making the same mistake, but also you *will* wind up with some paradoxes that you *can't* understand where they're coming from.



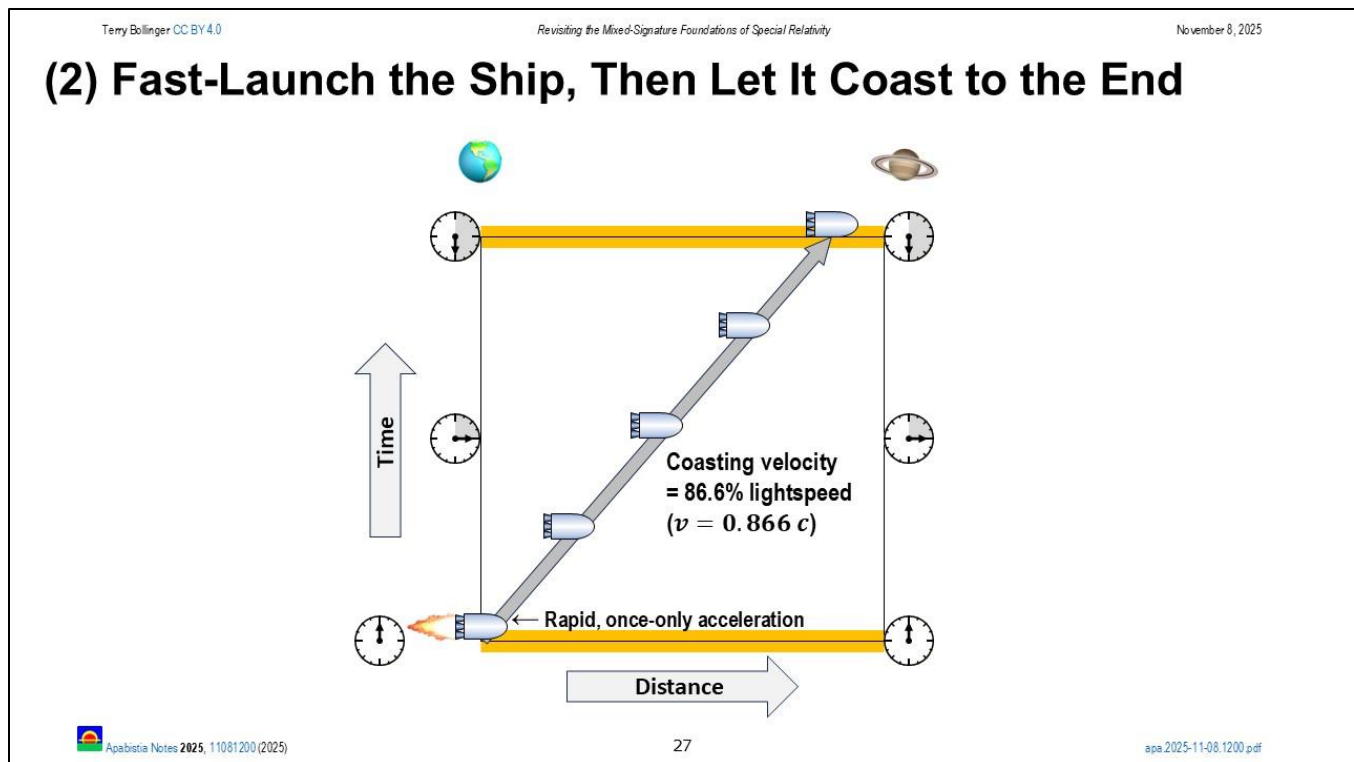
So, going back to the constructed thing, the symmetries (the Poincaré bubbles) are constructed. The interpreted symmetries are just how you interpret that outer space and the constructed symmetries are *very* local. They can only expand at speed of light, so you want to take that into account, and the bottom line is I'm saying that this *is* a topic that needs to be addressed. It's a topic with practical implications, such as for GPS satellites.



[51:32] Now, I keep talking about saying Euclidean models of special relativity, and this is where I may... I *am* going to speed it up at this point, because I think I'm supposed to take about an hour here, but let's go through this and this is something you can look at later if you're interested in the topic. If not, don't worry about it, but if you're interested in the topic, these figures that I'm going to follow with (that I'll go through quickly) *will* show you with quite a bit of specificity how you go about making special relativity Euclidean. So the first thing to do is... how do you *transfer* the concept of an accelerated spaceship or of a particle or something point-like, something where you don't care about the details... You're just saying, I have something moving.



[52:21] So, first thing you do, you get this nice, neat square here, where you have the time units and the distance units are exactly matched up. This is, like, a light year at the bottom and a year of time at the top. It could be a nanosecond at the bottom, and almost exactly a foot going up. So you have these square symmetries, so it just makes things easy. It's a very common technique in physics to do this, but these could be very large. You have to see the illustrative example. You have Earth over there and you have Saturn out there, so this maximum time might be the time between Earth and Saturn, would be an example. It doesn't really matter what the exact unit is, as long as you keep it square like this.



[53:03] So, the acceleration assumption I made before is: Let's not dwell on the acceleration too much and there's some reasons why we want to be a little careful about that, because you can *distract* yourself with acceleration and lose the *incredibly important* importance of speed itself, the velocity through the cosmic photon database, because you're *moving* through it and you're hitting it and you're running into the data from it and you're *interacting* in terms of reading the state of the rest of the universe. You *can't* ignore that. That stuff is existing data.

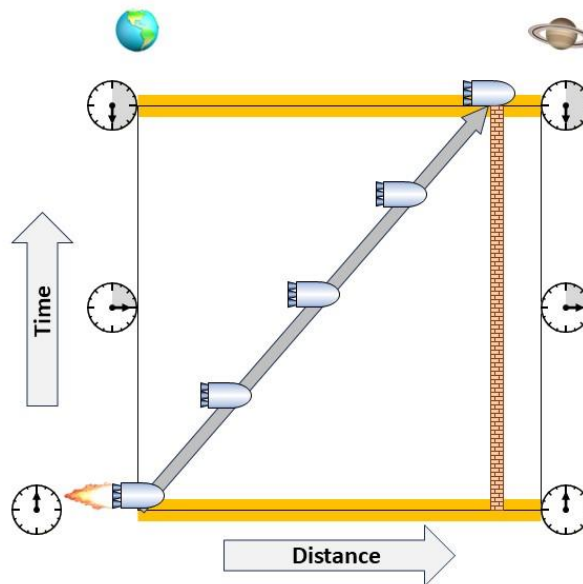
So you accelerate rapidly, so we can focus that. We can get some abstractions for that later. We know that it's possible, and for instance an individual particle can accelerate to *incredible* rates at very high speed, so we use that as an assumption, and that takes you to this idea that, okay, you can go up to this point on the far upper right corner on how fast you accelerate. So this is a... this spaceship is hauling. It's going at 86.6% of light speed, which is the 1 half Lorentz factor.

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Revisiting the Mixed-Signature Foundations of Special Relativity

November 8, 2025

(3) Drop a Vertical “Wall Line” from Journey’s End



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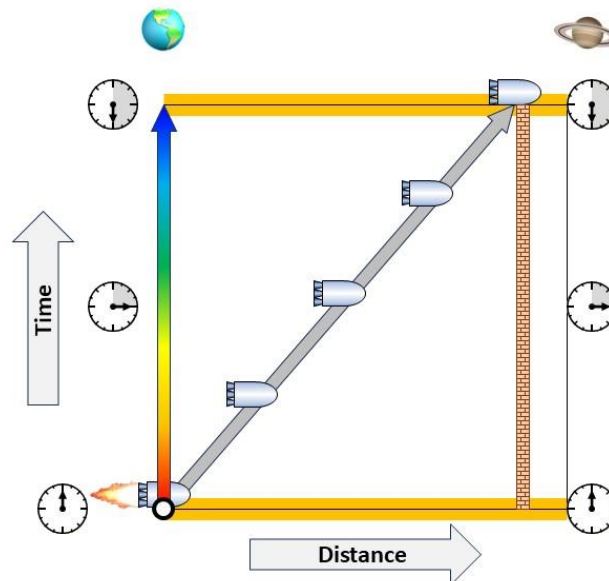
[54:13] Now, draw where the ship hits on the top line after the unit of time. So you see, it's almost there. It's about, you know, almost 90% of the way there, and just draw a line straight down from it.

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(4) Draw a Rigid *Invariant Edge* Over the Time Axis



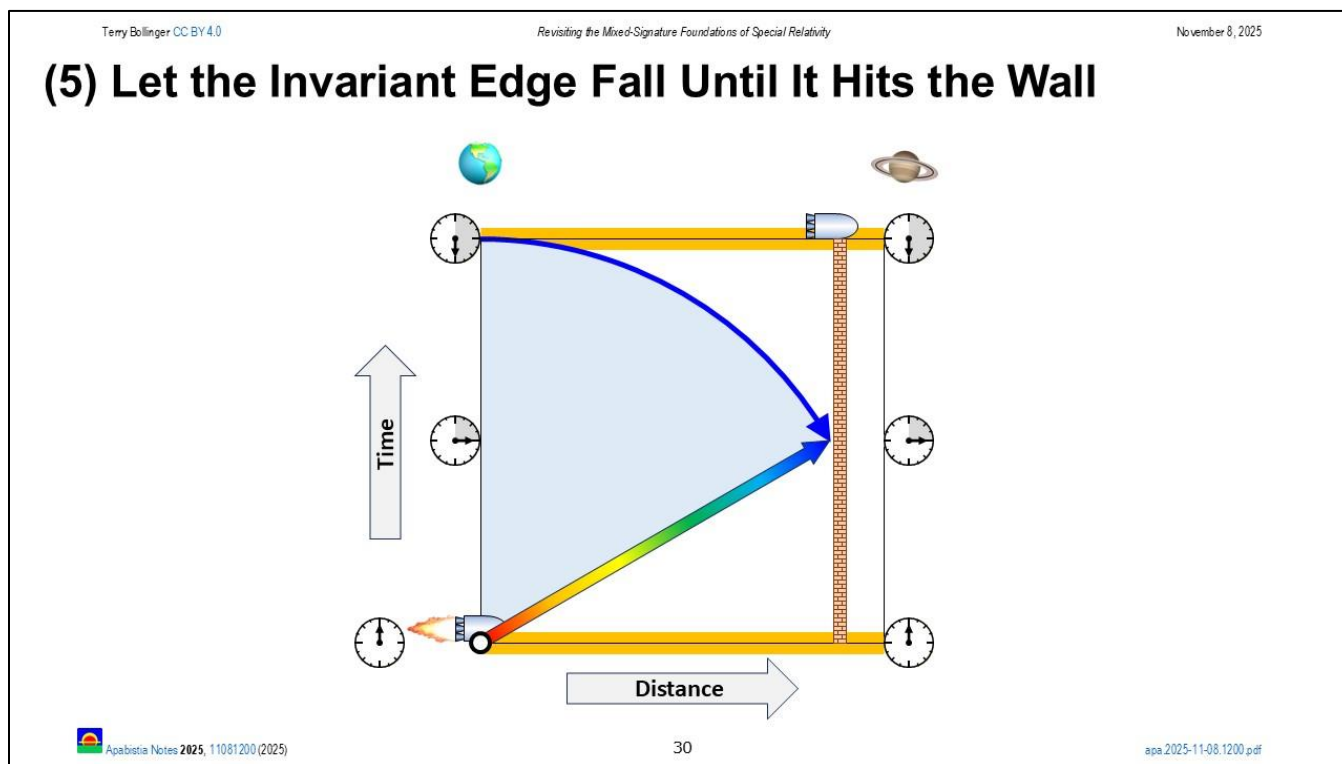
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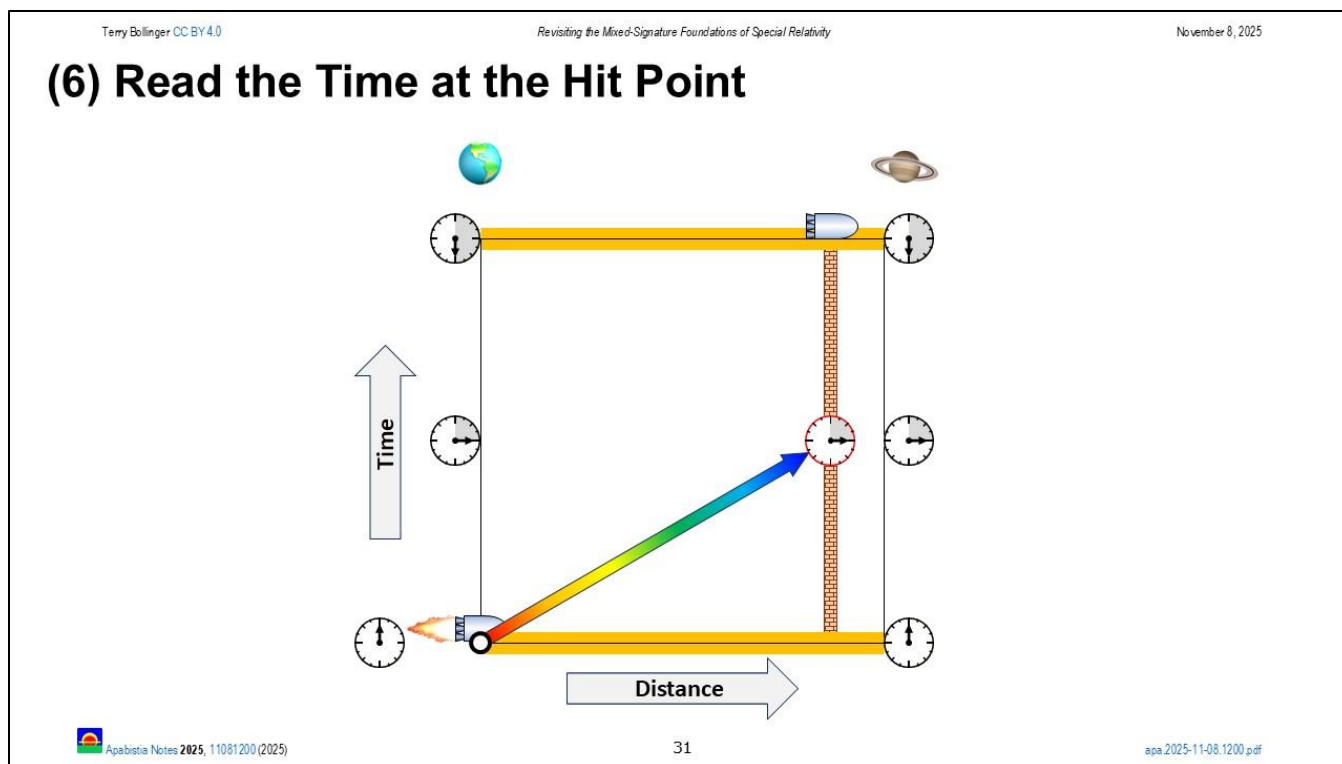
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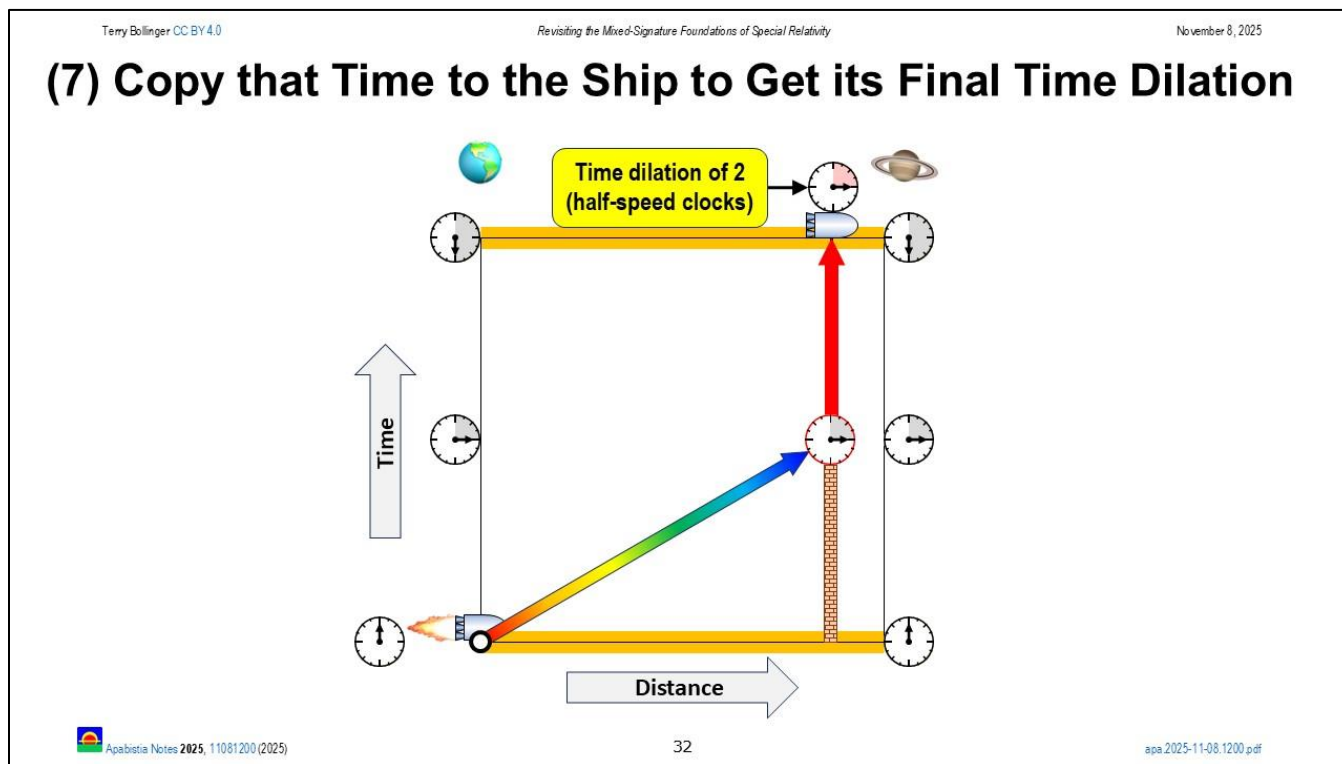
[54:27] I said I was going to this... This is where I start speeding up a bit. Now, draw another line over on the left-hand side. This is a very geometric exercise I'm going to take you through here. That is what I'm going to call an invariant edge, and why I call it that, it doesn't really matter, just go with it for the moment.



[54:45] Then you take your invariant edge and you flop it over like a wood beam, until it whacks into the wall that you made with that spaceship drop line. So you just say [{vocalizes noise: *shunk*}]. Let it fall over and it lands at some spot on that wall that you created, and then you say “Hmm, where did it land?”. So I say “Well, let’s see. Where did it land horizontally? It landed at one half time unit. Oh, that’s interesting. I wonder why it landed a one half time unit.”.



[55:16] So, you take that one-half time unit and you say “I’m going to project that up to the spaceship.”. Why are you gonna do that?



[55:24] Because, you find out experimentally it says “Oh, that’s exactly what the spaceship clock reads. Isn’t that interesting?”. So, that falling... [55:35] that little falling line there predicted what the time would be on the

spaceship. Now, all the other clocks, on Earth and Saturn... and again, it doesn't matter how far apart they are, this is all just standard... you know... inertial, single inertial frame, because they're not moving very fast relative to each other. Seems fast to us, but compared to the speed of light... you know... it's not much at all, but the *spaceship*, the spaceship is hauling and its clocks look different, so you have time dilation. which you calculated just by essentially letting a... dropping a line and letting another line fall over onto it.

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Why Does this Method Work?

Experimental givens

c in m/s , $0 < c$
 v in m/s , $0 \leq v \leq c$
 t in s , $0 < t$ ($t_e = t$)

Geometries

$x = vt$
 $x_c = ct$
 $t' = at$

Conclusion

$t' = \gamma^{-1}t$ (same as in special relativity)

From special relativity

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

Derivation of a

$a = \sqrt{1 - (x/x_c)^2}$
 $= \sqrt{1 - (vt)^2/(ct)^2}$
 $= \sqrt{1 - (v/c)^2}$
 $= \sqrt{1 - \beta^2} = 1/\gamma = \gamma^{-1}$

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[56:13] *Why does this work?* Now, I didn't *prove* this obviously but I'm saying, like, well, isn't that an interesting coincidence that in *this* case it came out with exactly the prediction of the Lorentz contraction? Well, it's *not* a coincidence. If you go through the geometry of it and go through these derivations, what you find out is that t' (the time of the spaceship) is equal to exactly γ^{-1} ($1/\gamma$) times the time, which is the correct prediction.

So, what this is is simple Euclidean geometry that gives the same results as special relativity. So there is an equivalence. So I can say "Oh, so this works for *any* distance, at *any* velocity." All I have to do is draw how far the spaceship went at the top. Drop a line, drop my invariant edge over on it and I will find out what the time was for that clock. So that's interesting. So you say... but think about it, this is already an example of driving the Lorentz factor without invoking any kind of a concept of a mixed signature space.

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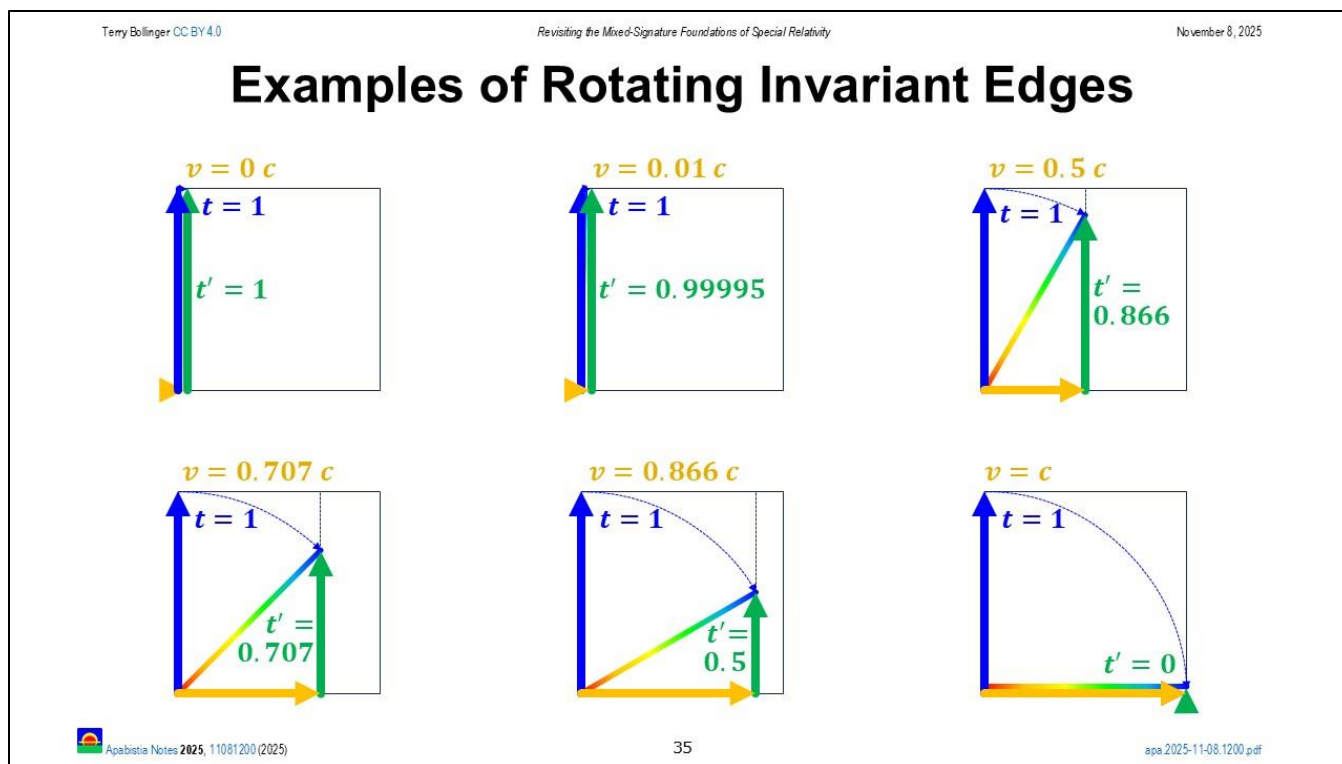
Special Relativity as Sines and Cosines

Experimental givens c in m/s, $0 < c$ v in m/s, $0 \leq v \leq c$ $t = \hat{t}$ in s, $0 < t$ Geometries $x = vt$ $x_c = ct$ $t' = t/\gamma = t\gamma^{-1}$ SR from theta $v = c \sin \theta$ $\beta = \sin \theta$ $\gamma^{-1} = \cos \theta$	From special relativity $\beta = v/c$ $\gamma = 1/\sqrt{1 - \beta^2}$ theta ($0 \leq \theta \leq 90^\circ$) $\theta = \tan^{-1}((x/x_c)/(t'/t))$ $= \tan^{-1}(\beta/(1/\gamma))$ $= \tan^{-1}(\beta\gamma)$ $= \tan^{-1}(\beta/\sqrt{1 - \beta^2})$ $\cong \beta$ radians (if small) $\gamma^{-1} = \sqrt{1 - \sin^2 \theta}$; $\gamma = 1/\cos \theta$	
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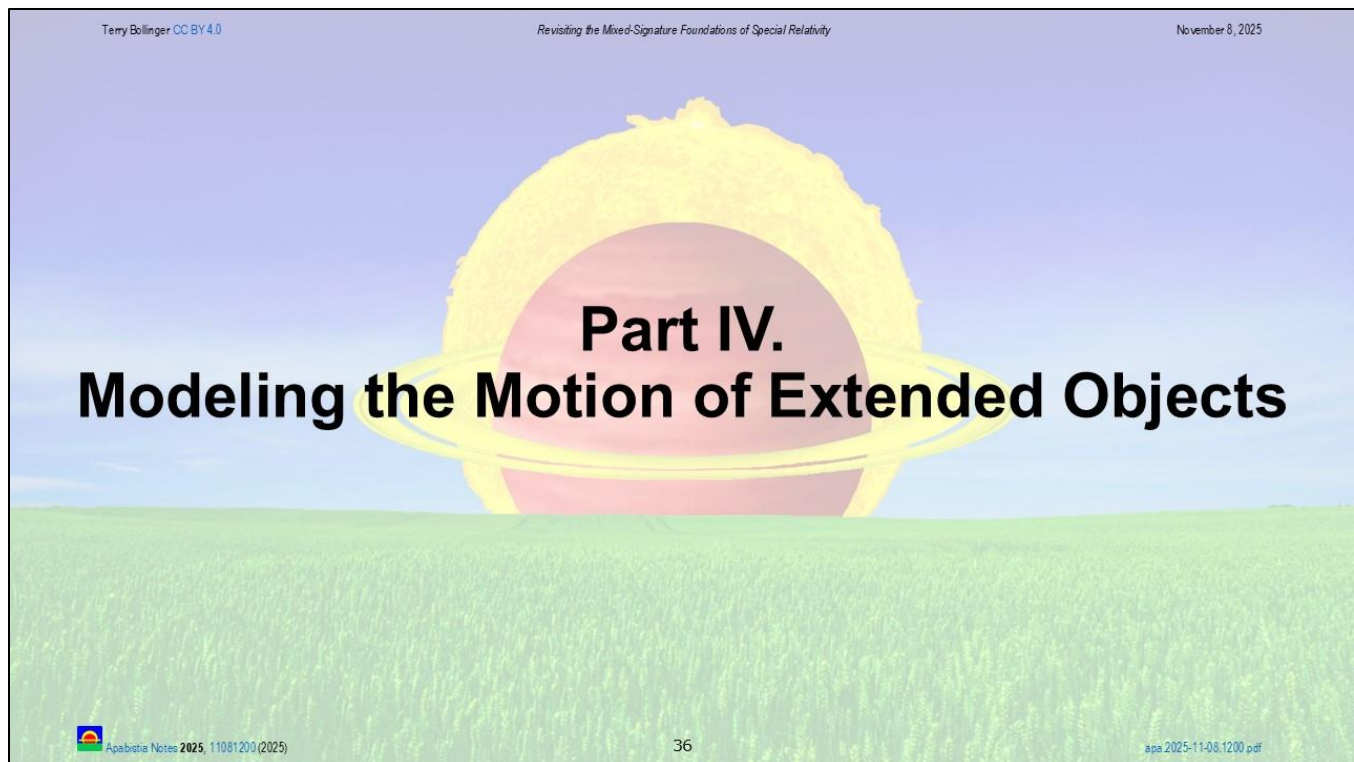
[57:24] Even more surprising (and I have had people be very surprised when I said this), if you go to the literature of special relativity, it's full of hyperbolic sines, hyperbolic cosines that deal with the mixed signatures that you have in relativity. When you use this Euclidean method, those disappear, and what you get instead is that the γ factor (the Lorentz contraction factor) just becomes sine of an angle, of the angle of that falling line, the one that went plop and ran against the wall.

You measure that angle, and then sine of that gives your velocity... I'm sorry. Sine of that gives you velocity, then the *cosine* of that gives you the inverse of the Lorentz contraction factor. So you've derived the two main components that you want for relativistic problems just from the sine and the cosine and *that's* simpler than it's supposed to be. So, it's... [{laughs}] They're not supposed to be just sine and cosine, but they are. It's just... If you follow the Euclidean geometry it just makes it a little simpler.

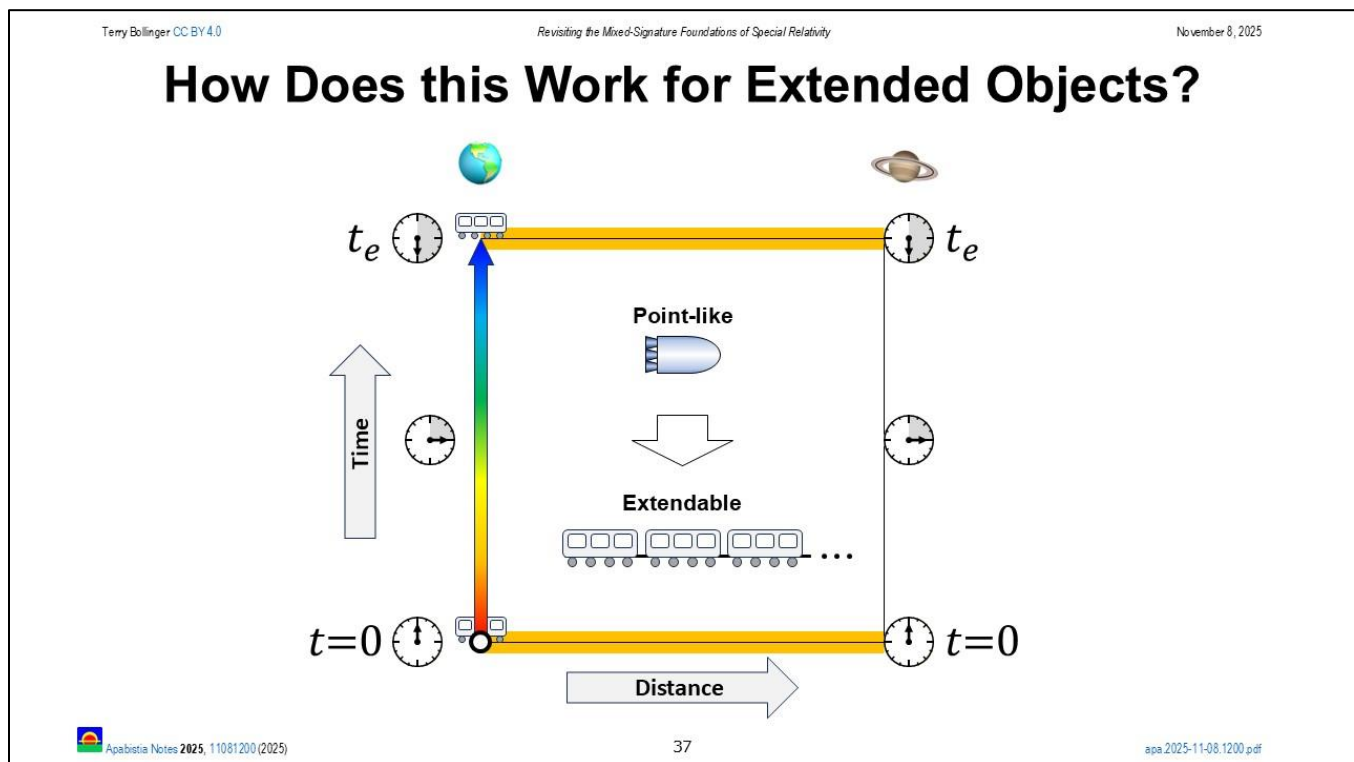


[58:39] Here's a bunch of examples. So you start out... and it just gives you an intuitive feel for what's going on with this. Velocity zero, time equals one, the new timing is equal to one, no surprise... You go over to the right at 0.866, you get this thing where you get this... well, not point... having trouble... at velocity of 0.5... I've got a little block over my figure here... At a velocity of half of light speed you get this time dilation of having the clock say 0.866 units of time, but again, it's the same... the same example there. You just see it. Let it fall over, [{vocalizes noise: *plunk*}] and then measure out that time.

You can actually do this in analog mode if you want, then you have 0.707 light speed, so you just see it just keeps falling, and what happens at the far right? When you reach the velocity of light it falls all the way over and time falls to zero. You're no longer... Everything's been wasted on distance and *none* of it has time anymore. You never get above the clock time of that little unit.

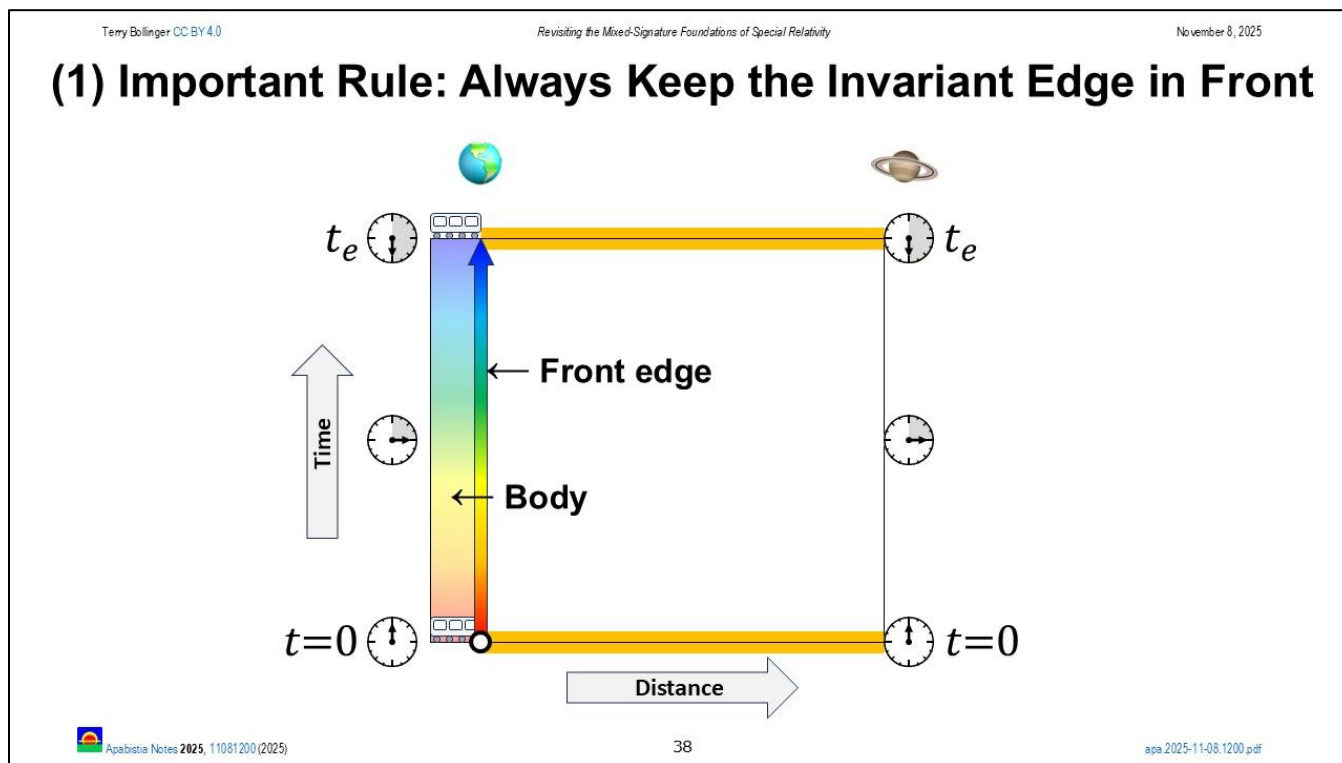


[59:48] Okay, now that was a point-like object, so...

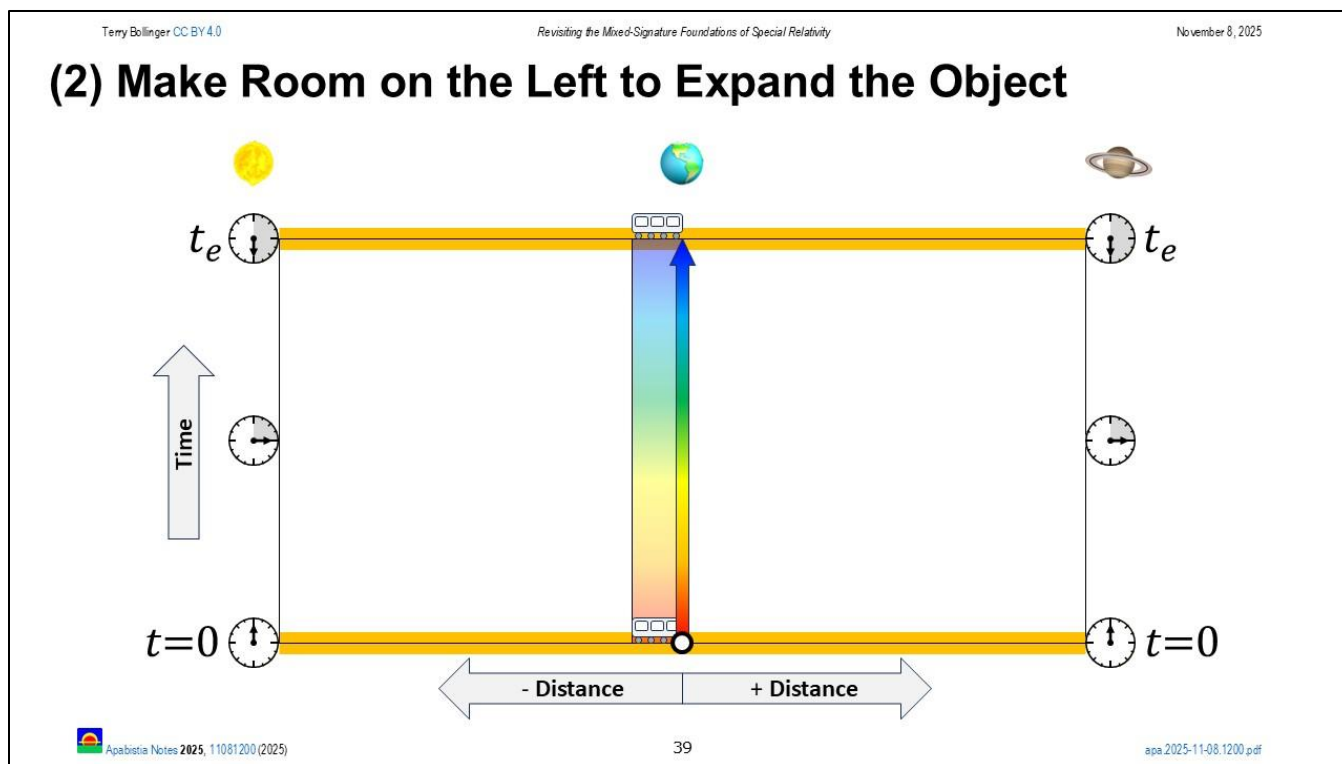


[59:53] Let's go to the example quickly (more or less) of an *extended* object, because point-like objects are kind of boring, and Einstein used *very* long trains with *very* high velocities and never quite put the equation down for

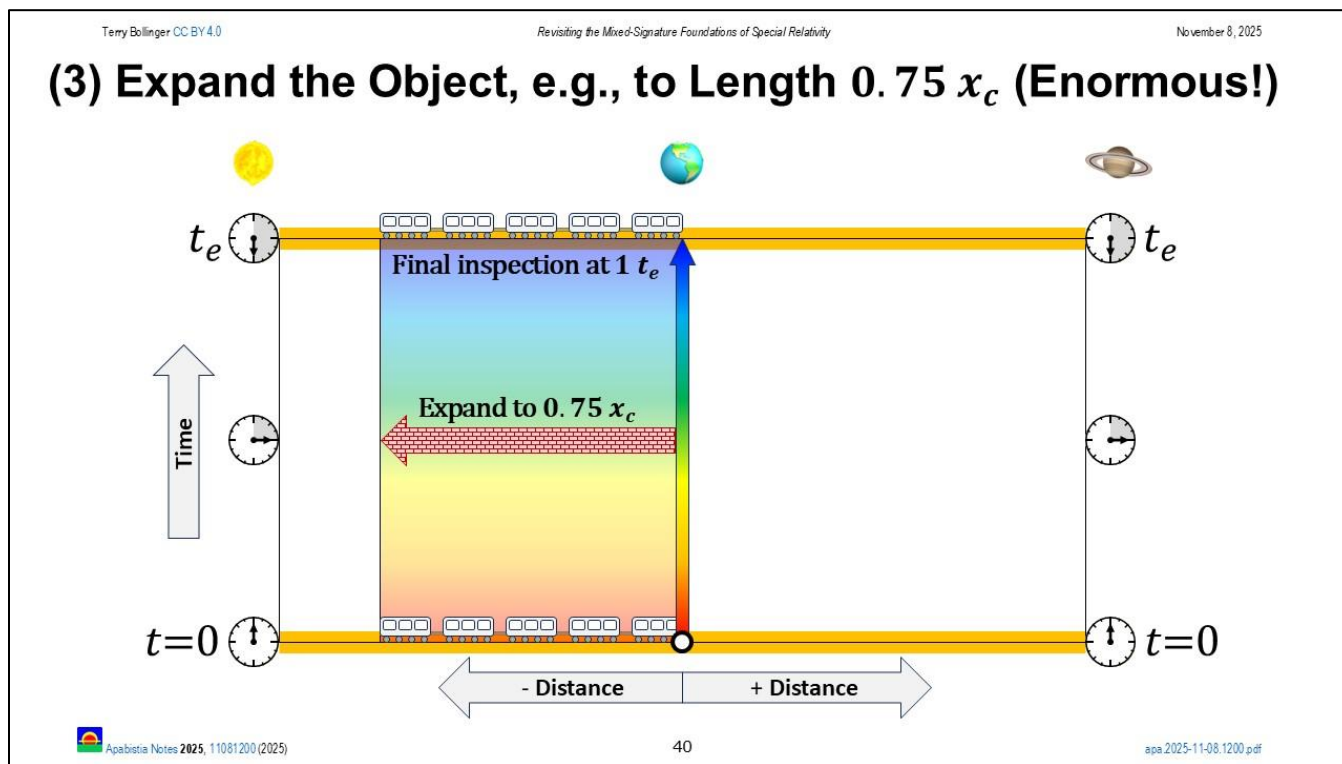
solving what the time prediction would be. He never put a clock in the front or the back of the train and that's not exactly a coincidence.



[1:00:20] So, let's make a train, and I'm gonna suggest something. Now, why I'm doing this is not obvious, but there's actually a very good reason for it. Let's make the train go *backwards* from that leading edge. This is why I was calling it the invariant edge. We start with the same problem we had before. We already showed that that gives you the same results as special relativity, but you start extending your object backwards.



[1:00:44] So you make it bigger. Let's get a little more room here...

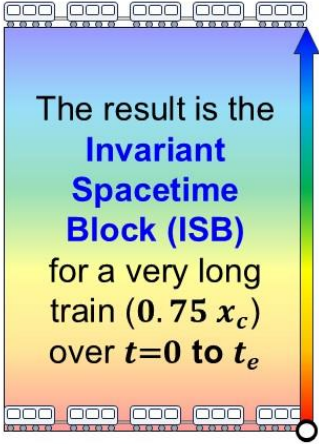


[1:00:48] Let's expand that puppy out there into some *enormous* distance. This is a *very, very* long train. So... you know... if we're talking about interplanetary [distances] this is a train that would run a good part of the distance between *planets*. So, obviously not relevant to anything... Whoops, what am I saying? *Of course* it's

relevant to things we're doing. We have satellite systems that actually have these kinds of geometries. So this is not an abstract problem, this is a real problem that pops up in astrophysics (in modern astrophysics, in modern engineering), so these aren't arbitrary. GPS satellites, again, is a smaller scale, but still very relevant... If you're trying to tell people where to turn and not turn off one meter too soon and go into a lake, you need to know this stuff. So we got this *long* train, we're going to put it backwards, and we want to see what happens when we try this method on this long train.

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(4) Length $\times$ Time is the Invariant Spacetime Block (ISB)



The result is the
**Invariant
Spacetime
Block (ISB)**
for a very long
train ($0.75 x_c$)
over $t=0$ to t_e

- **Claim:** The simple block shape of an ISB **stays unaltered** for all velocities from 0 to lightspeed.
- To specify a block velocity, **tilt the block forward by θ** at its forward edge (front of object).
- Once tilted, the block predicts the **lengths and clock values** for all object parts, as measured by instruments in the launch frame.

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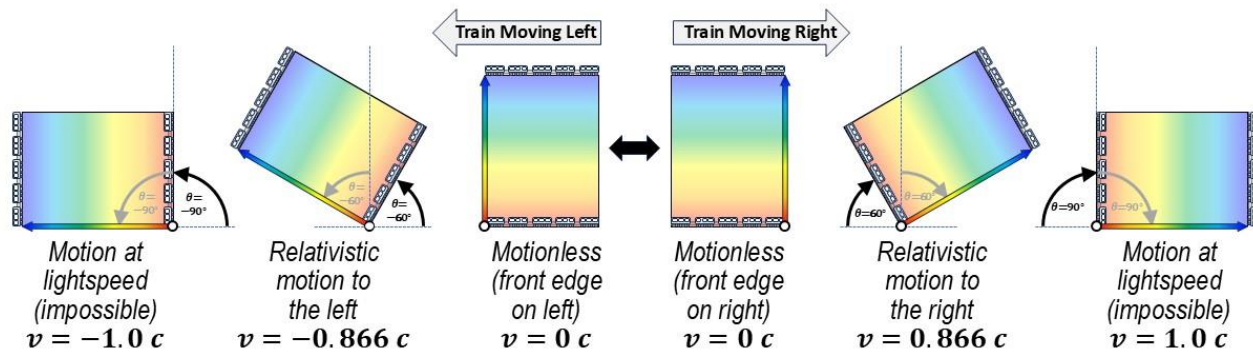
[1:01:46] So, I'm going to give a *name* to this block. If you look at this colored-in section, this is what I'm going to call (and again, just arbitrary definition at this point) invariant space-time block. This is the length of the train going *backwards* from the front of the train. Very important, as it turns out, and then up through time, through whatever time period it is, you're going to start doing your next checks. Your next tests will come at the top of that block. So you've got time zero at the bottom, you've got some time, it can be anything you want, it doesn't matter what the time is. The length can be anything you want, it doesn't matter. So you just form a rectangle, and the *assertion* is...

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(5) Examples of Invariant Spacetime Block Tilting



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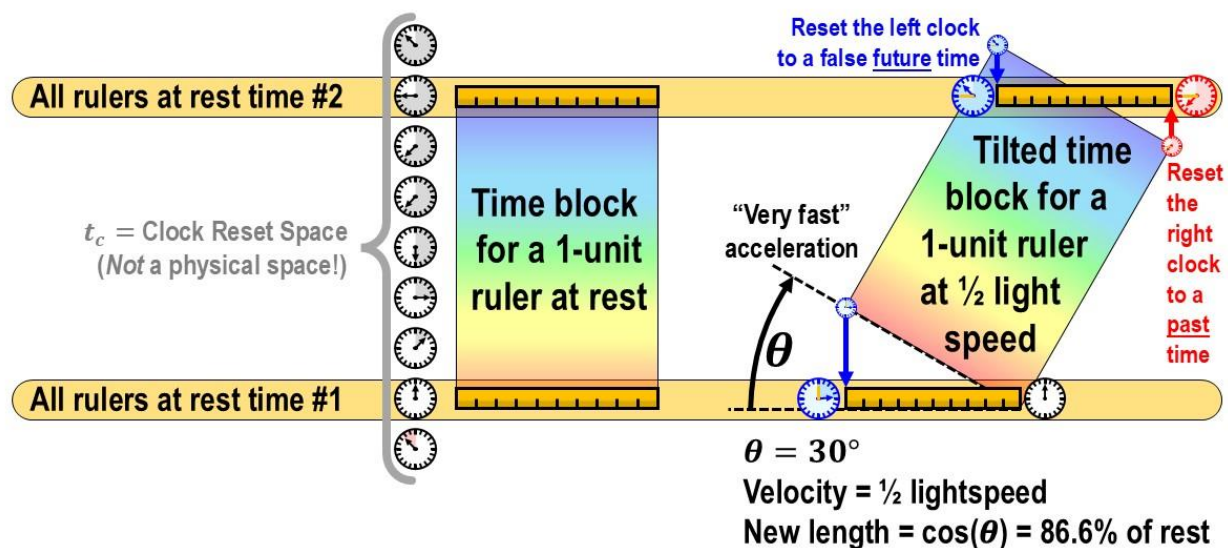
[1:02:31] ... that once you *do* this, you can tilt the entire block just like you tilted the individual line. The individual line gave you the standard Lorentz predictions, so this is a stronger assertion. Now I'm saying that you can take this entire *block* and do that kind of prediction, that you can take that. You say "Well, that doesn't sound right. There's all sorts of squirrely things going on here. That can't possibly be right." Let's take a look at it.

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Using Tilted-Blocks as Lorentz Calculators



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[1:02:59] So, the assertion is that you tilt the block and the front of it... you know the front's gonna give you the right answer. That's not a problem, because we already derived that. The front edge gives you the right answer, but what about all... what's going on with this *left* edge here? What is all this stuff? For instance, if you look in the right-hand block here, you're actually *tilting* the clock times on the ship, on the train (this guy's got a ruler) into a different setting and you're actually *shrinking* the ruler. So what's *that* all about? Because... Is that what actually happens?

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Why Do the Train Cars Have Different Times?

- Einstein first realized that objects in a moving frame cannot be simultaneous when tested from another frame. One can find this "time slope" by starting with Einstein's frame conversion equation:

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

- Applying the above to two x points gives the time slope α :

$$\alpha = \frac{\Delta t'}{\Delta x} = \frac{t'_2 - t'_1}{x_2 - x_1} = \frac{\frac{\gamma}{c}(ct - \beta x_2) - \frac{\gamma}{c}(ct - \beta x_1)}{x_2 - x_1} = \frac{\gamma}{c} \left(\frac{-\beta x_2 + \beta x_1}{x_2 - x_1} \right) = \frac{\gamma}{c} \left(\frac{-\beta(x_2 - x_1)}{x_2 - x_1} \right) = -\frac{\beta\gamma}{c}$$

- Summarizing:

$$\text{Time slope of a moving object} = \alpha = \frac{\Delta t'}{\Delta x} = -\frac{\beta\gamma}{c} = -\beta\gamma c^{-1}$$



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[1:03:35] As it turns out, yes, that is *exactly* what happens. If you follow Einstein's equations about how to translate coordinate times and go through a derivation across two points (two different locations) you wind up with this slope, with this ratio, and the ratio, if you go through the derivation, you get it's minus beta (β) gamma (γ) to c^{-1} [c to the minus 1, that is, one over c). So...



Converting the Time Slope to an Angle

From the earlier slide on trigonometric special relativity using θ :

$$\beta = \sin \theta \quad \gamma^{-1} = \cos \theta \quad \gamma = 1 / \cos \theta \quad c = x_c / t_e = 1$$

Time slope of a moving object (from Einstein frame equations):

$$\alpha = -\beta\gamma c = -\sin \theta / \cos \theta = -\tan \theta$$

Deriving θ from Einstein frame-conversion time slope:

$$\alpha = -\tan \theta$$

$$\tan \theta = -\alpha$$

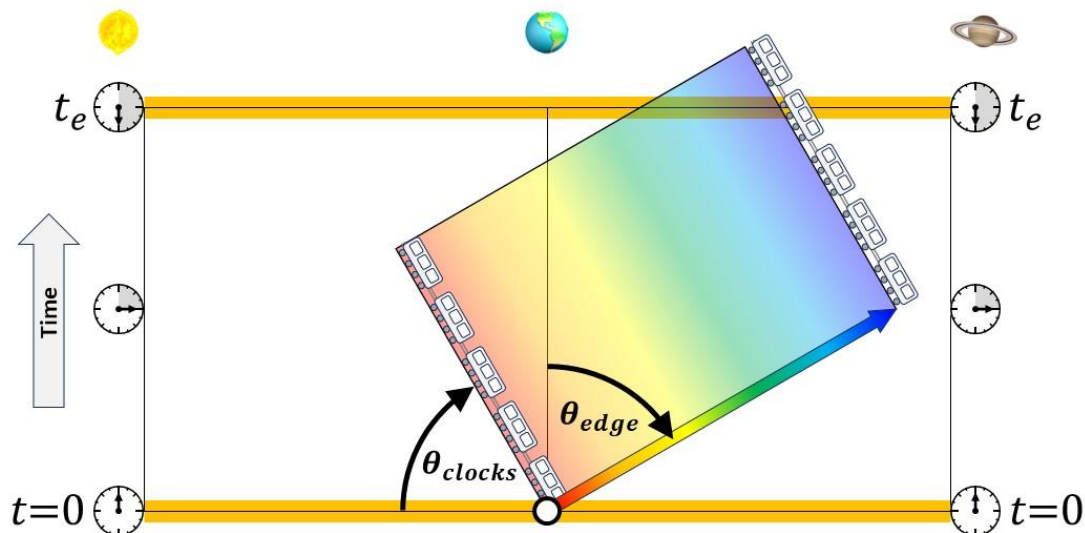
$$\theta = \tan^{-1}(-\alpha) = \tan^{-1}(\beta\gamma) = \tan^{-1}\left(\beta / \sqrt{1 - \beta^2}\right)$$

$$\theta = \tan^{-1}\left(\beta / \sqrt{1 - \beta^2}\right) \text{ — Same as for point-case invariant!}$$



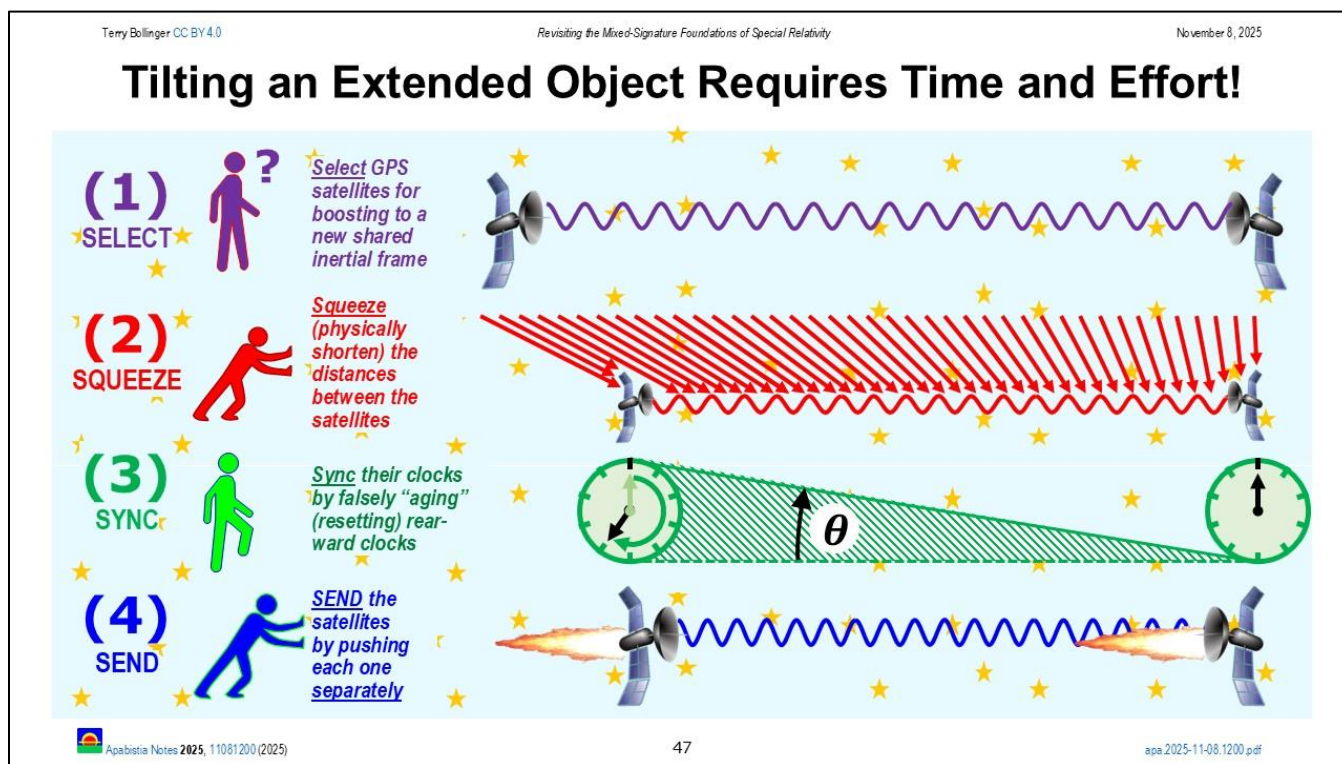
[1:04:04] ... it's a fancy way of saying that you have an *angle* that comes *from* that that is theta (θ), but the theta that you get happens to be exactly the same theta that we got earlier for the single-point case.

Two Identical θ Rotations Keep the Block Invariant



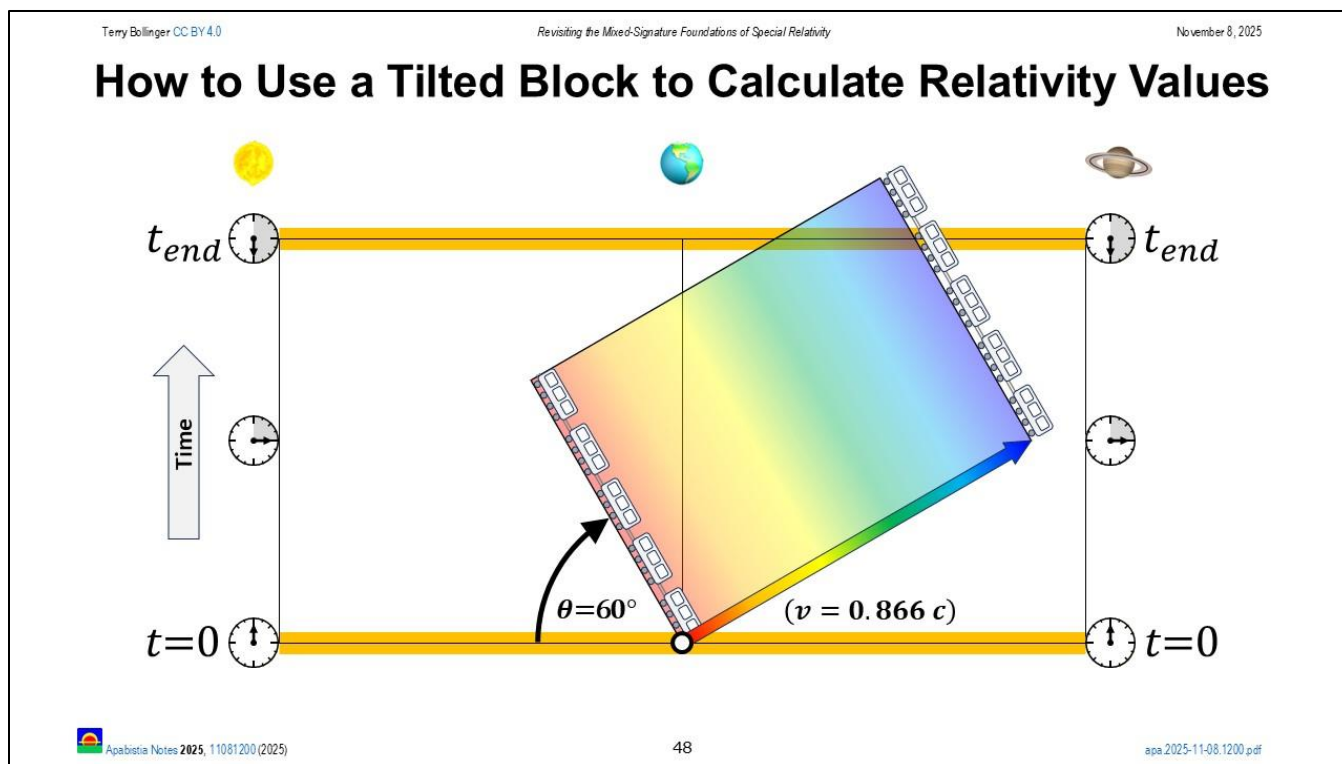
[1:04:28] Well, that's interesting. What it means is when you rotate a large object in this space you wind up having to bend the time settings of that clock and also their locations so they exactly match the ones that you got

for the right-hand invariant line. That's why you wind up with this block. You have a derivation in which *both* the orthogonal dimensions wind up having the same theta (θ) rotation and you wind up with the same result, but it also means that when you launch something it's *not* trivial...

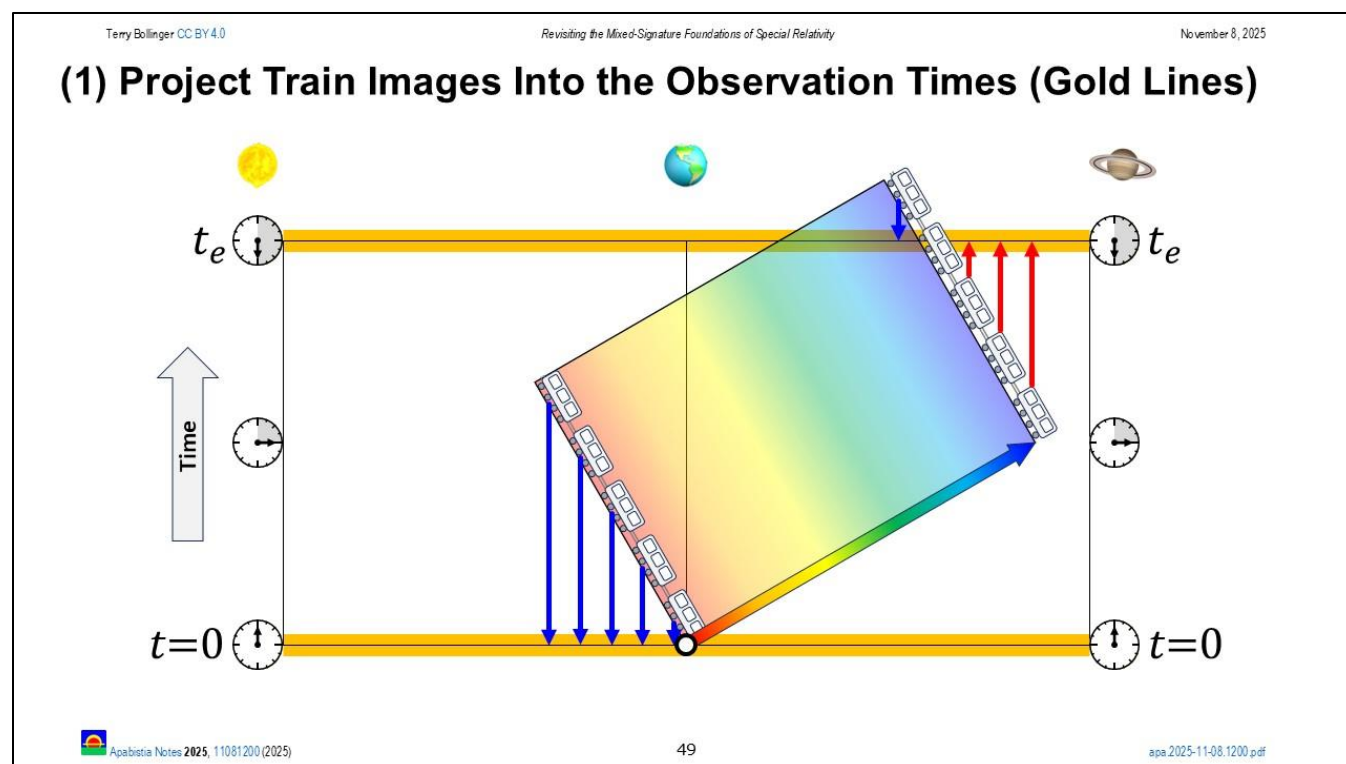


[1:05:06] ... not trivial *at all*. In fact, here is a description of all the states that you have to *do* in order to make a *real* system, such as satellites (which are easier because you don't have to worry about compressing matter). The satellites... If you have distances and you want to say "I want to put these satellites in a new inertial frame.", you have to go through these steps. You have to squeeze the satellites together, you have to *physically move them*, you have to actually accelerate and decelerate the satellites. This is not trivial.

So, you put them in a new location and then you have to reset the silly clocks and things. You have to say "I know you're not gonna like this, but you gotta set your new clock to *this*.", and that happens on the trailing edge. The front end, you want to keep synchronized with the rest of reality. That's that hierarchical issue again. *Only* after you've done those three steps do you do the send part. You can accelerate the satellites. You give them a quick burst of energy. They're set to go. They've got the new time settings. They got the new length, and all of a sudden, they *work*.



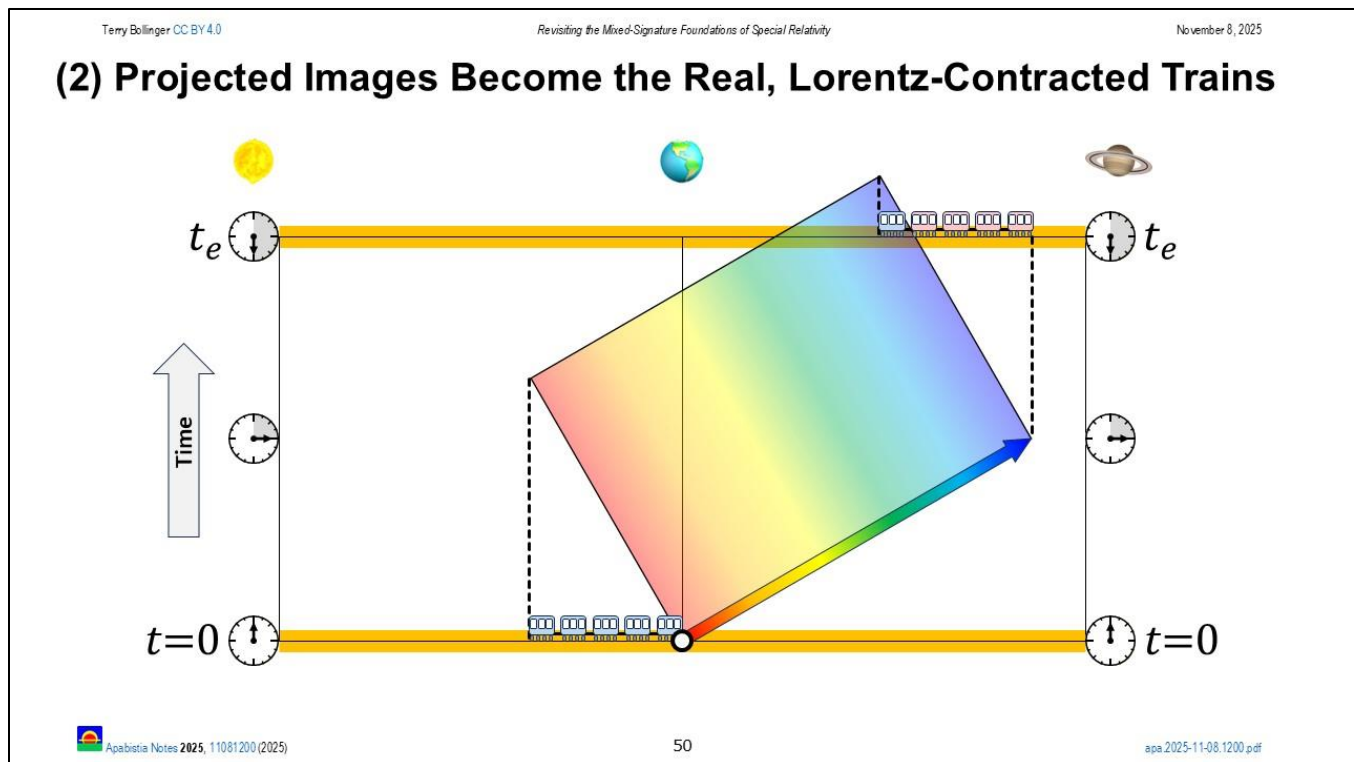
[1:06:06] They give you *this*. They give you the same thing that these trains get. You get perfect communications and *inside* of that block of the satellites talking to each other they now share a new time coordinate system that works perfectly well, but you had to do conversions during the acceleration phase to get this. So... and when I say that Minkowski space skips too slightly over acceleration *this* is what I mean. If you just say “Oh, acceleration’s just the second derivative of speed. It’s no big deal. I just boost it.”. If you say “boost” you have skipped every aspect of this. You’ve completely gone over it, and by... in doing so you can’t properly set up the system, and again, these are systems with actual engineering applications for modern technology, so it’s not an arbitrary set of coordinates.



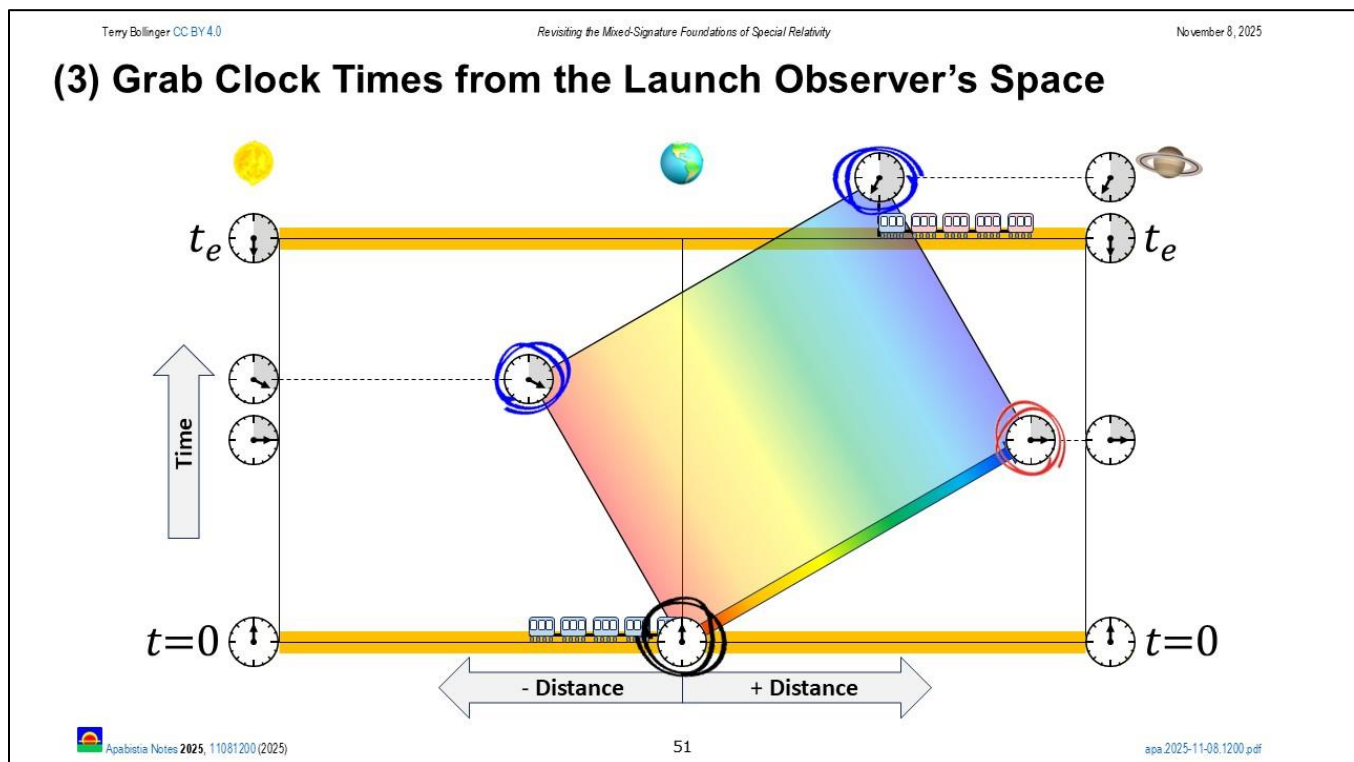
[1:07:00] Now, in terms of what you do, first you rotate... Let's give the example. You rotate the block. You got whatever you had there and you had this *really* interesting effect as if you just... that the real image of the train is in the *block* and everything else is a projection of that, and there may be some deeper meaning to that, because that is exactly how these things behave.

So, you project the *image* of that train *in the direction of time*. Where does the time come? From the master frame that you accelerated from. Very important to keep track of where your time pointers are going. The master frame always rules (the frame that you came from, what I call the fab frame) if you got those coordinates. It can be anywhere in that hierarchy, but you *have* to accommodate which definition of time is the one that you use for projection. Otherwise, you will not get a valid system.

So you project downwards and upwards (whichever direction you have to) to get to what you think of... The golden lines are the *real* instrumentation lines, the one where you *actually* measure reality. When something accelerates, it doesn't go into some different space-time definition. It's still there! So, you want to acknowledge that when you look at that train, it doesn't matter if it's in its own definition of space, you're still going to see it, and you're going to see it Lorentz compressed, and you're going to see it with its clocks all wonky; you're going to see a very real train passing by at a very real velocity. So, you want to always coerce these images back into these definitions of the instrumentation you use.



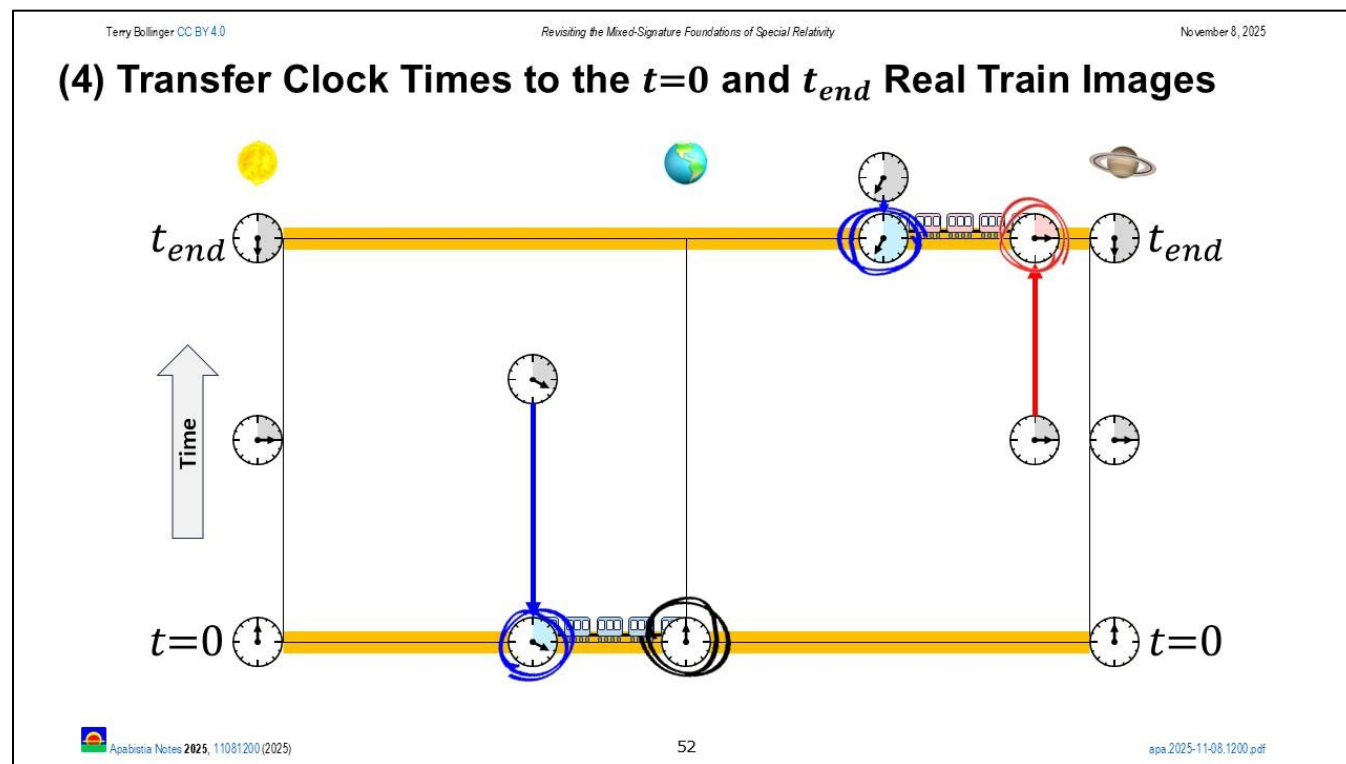
[1:08:41] Once you do that, you get Lorentz compression, because you compress the image of that train.



[1:08:45] You also get these *clocks* that you have to grab. From here you just show the ones in the tips. You get the clock from the *Euclidean* space, from the time space of the master frame, *not* from the new one. You have to

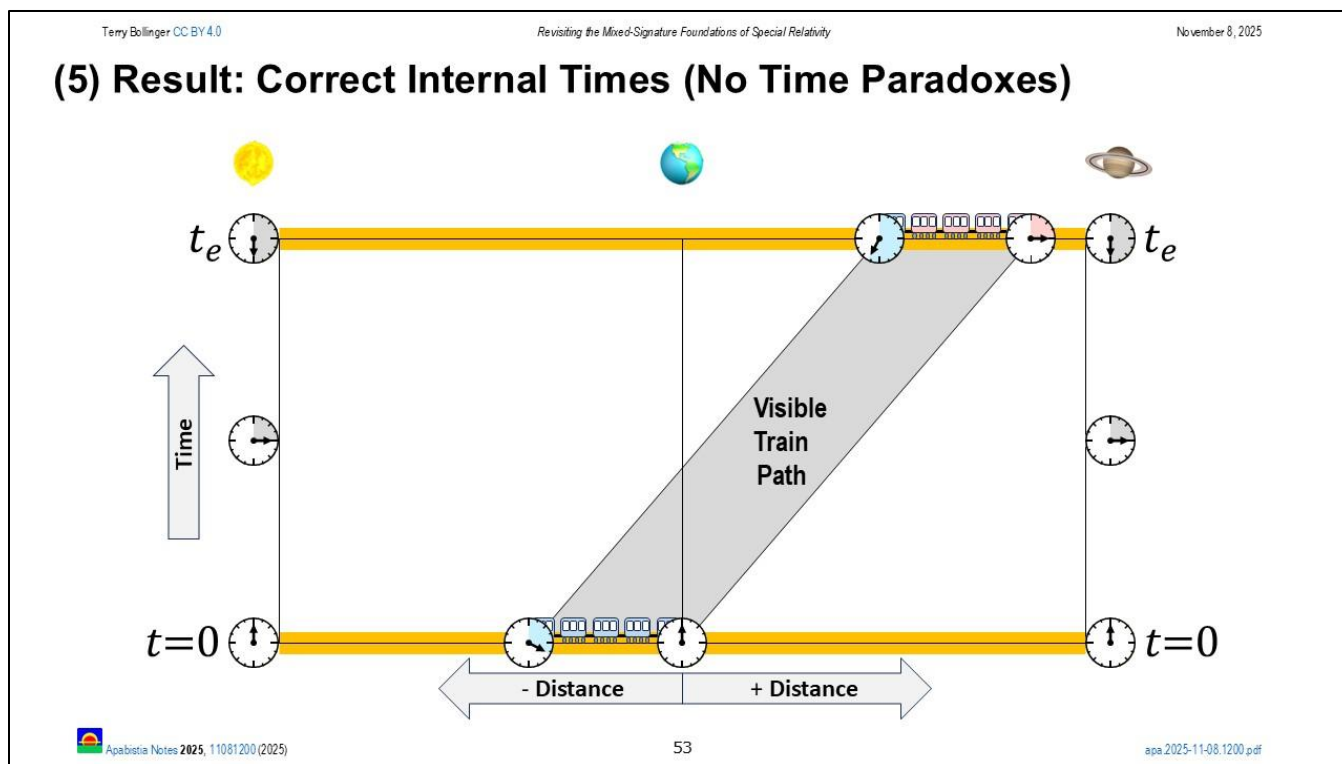
respect the time, because the master frame (the larger frame), that's the one that's creating all these instances says "Nope, you still gotta... You still gotta watch *my* coordinates. You still gotta share *my* coordinates."

So you grab those...



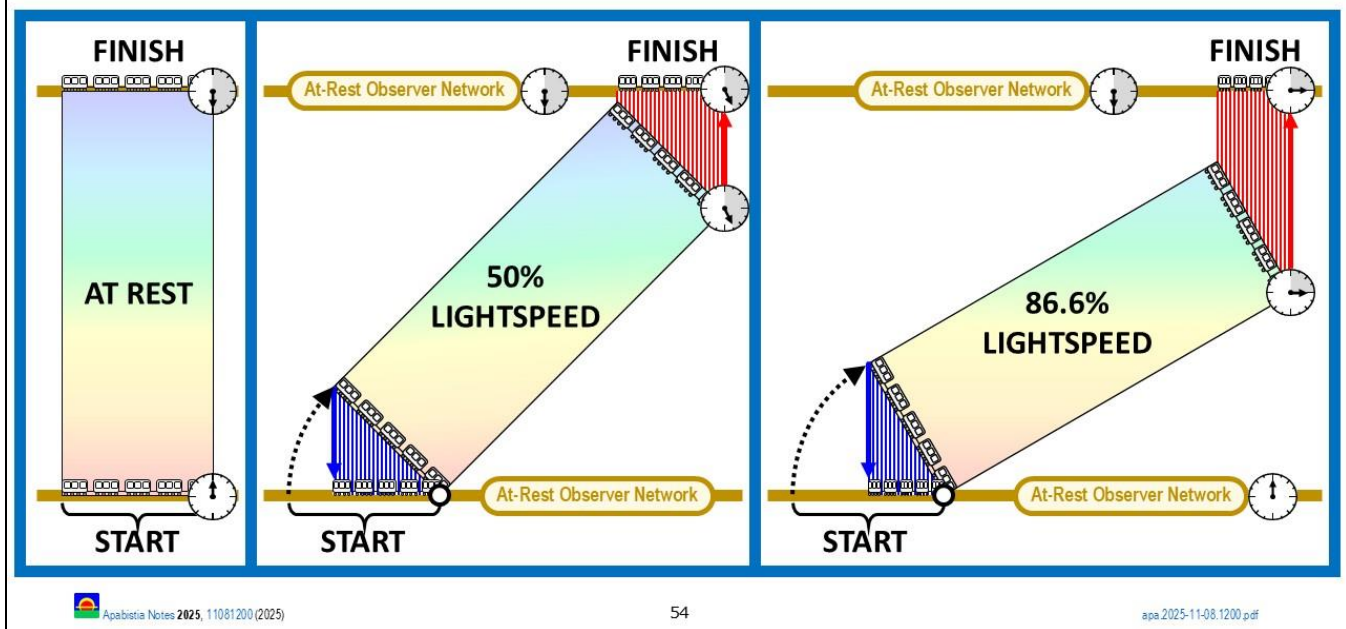
[1:09:12] ... and you drop those down, and then you find the clocks give you the correct settings for Lorentz contraction and you *also* find that your clock is not synchronous. Your *train* is no longer synchronous with itself, and that's kind of a wonky idea and the reason it's wonky is... The example I've given to friends is, in principle, if you're going fast enough, you could have the front of your brain to be... oh, I don't know, an hour out of sync with the back of your brain, in terms of the observing frame... and yet, from your perspective, you can't tell any difference. Your perspective will be a highly *time-dilated* perspective, but nonetheless you will see it as just ordinary time. You don't feel non-simultaneous, but the outside world looks at you and says "Whoa, you are *really* out of sync with yourself. So you get this *fascinating* effect of objects no longer being in sync with themselves, and yet this is exactly what you get with the predictions.

The train path?



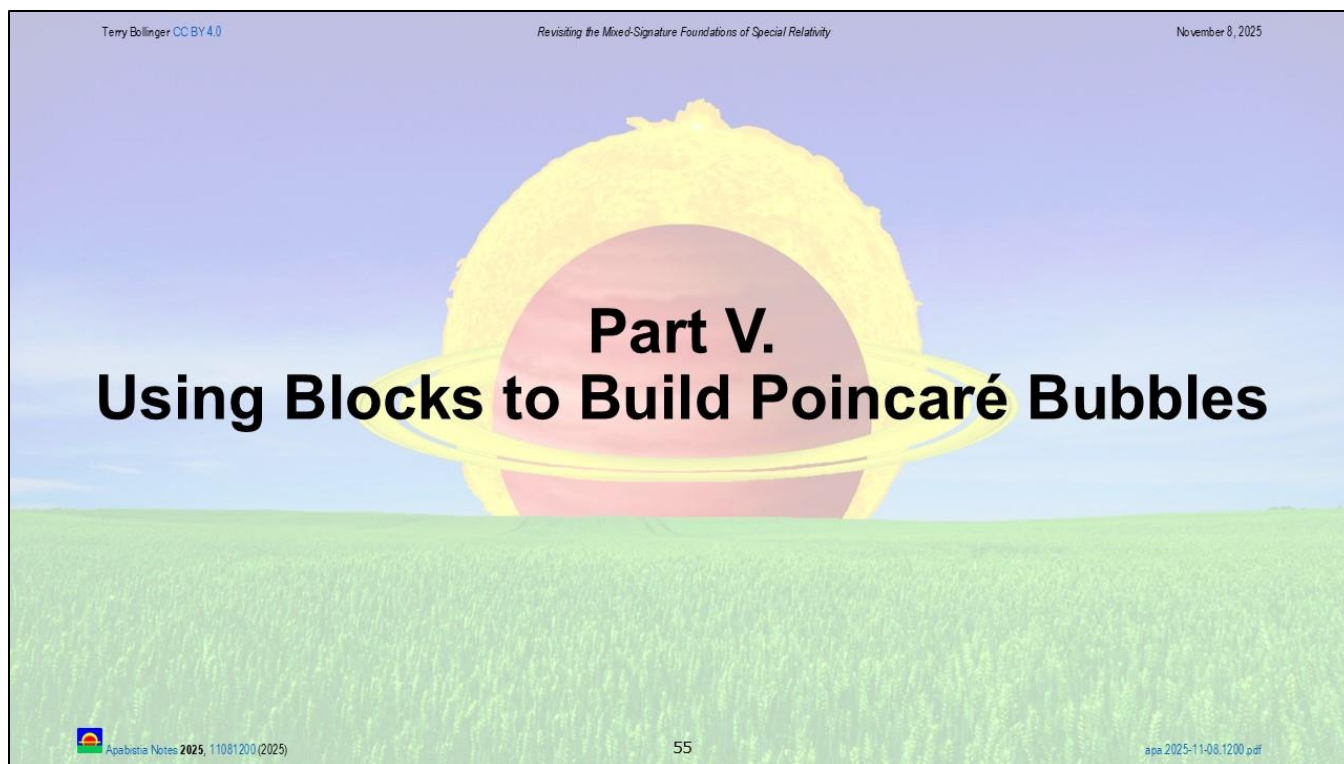
[1:10:19] It's just the path between those images. In some ways, the visible train path is the *least* interesting part of what you're driving with this, because if you don't pay attention to that tilted block you're not gonna know *where* these figures are coming from. You're like "Where, what...? What *is* all this stuff?". In fact, traditional spatial relativity does *not* do a good job of telling you what the back-end clock is supposed to say. You can figure it out, and usually it's laborious, but you don't have a simple path for getting there and saying "Well, what is the degree of asynchronization inside of the train?". This approach is saying that we always lock it down to the origin. You always lock it down to the existing coordinate system and then you do the transformations...

(6) Three Examples of Tilted-Block Special Relativity

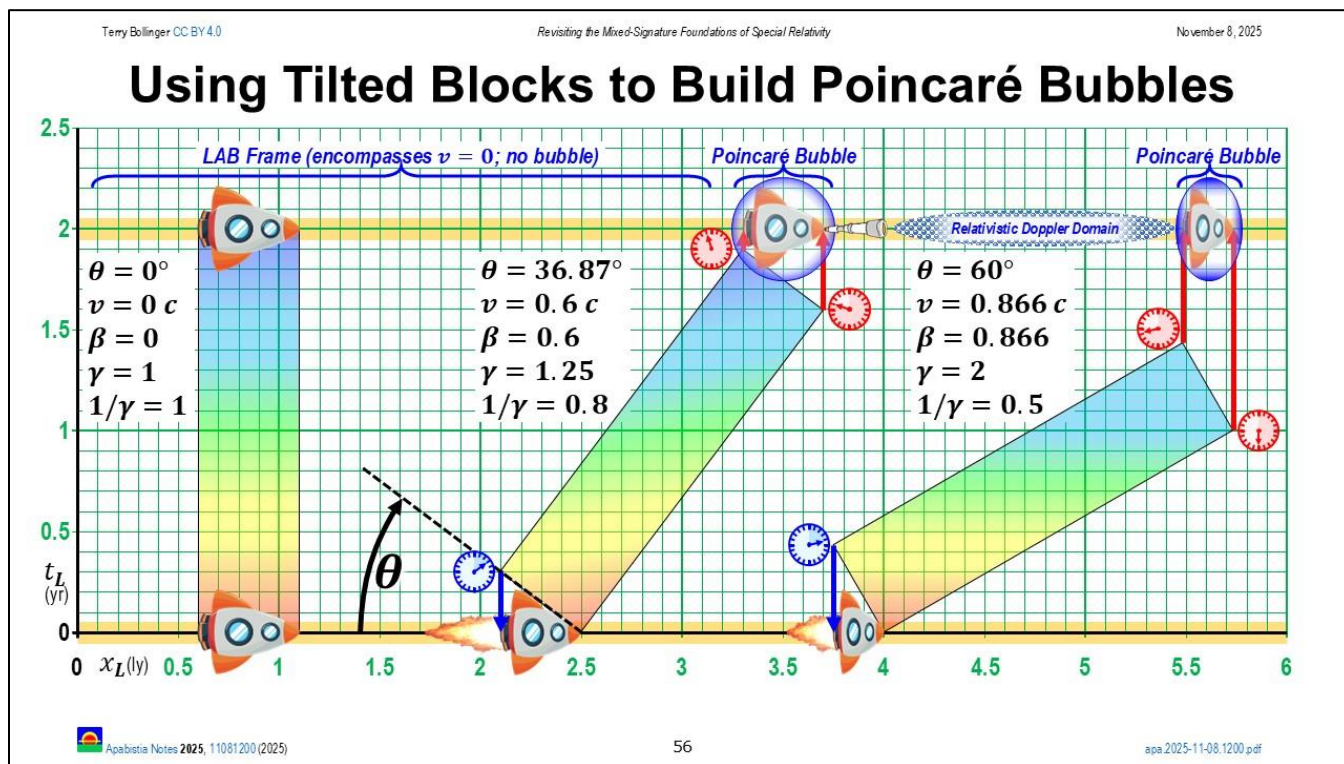


[1:11:06] ... and the transformations in the Euclidean space are not complicated. You have it at rest, okay? So you have an instrument line at the bottom, and you use that same instrument line at the top at a later time in the master frame (the larger frame). You use that as the LAB frame as I called it. You use those same instruments, you measure them out here, and what do you do? Whatever the tilt is of your block, you just project it up to the line, using the time axis as your projection direction.

So you get Lorentz contraction, you get a spectrum of time dilations, which again is *not* easily predicted for *most* versions of special relativity, but here you're just using Euclidean space and it's kind of, like *right there*. You say "Oh, okay, yeah.". The one on the far right is going to be one half of the clock speeds you would expect. You can literally create a little physical slide ruler type device to calculate these.

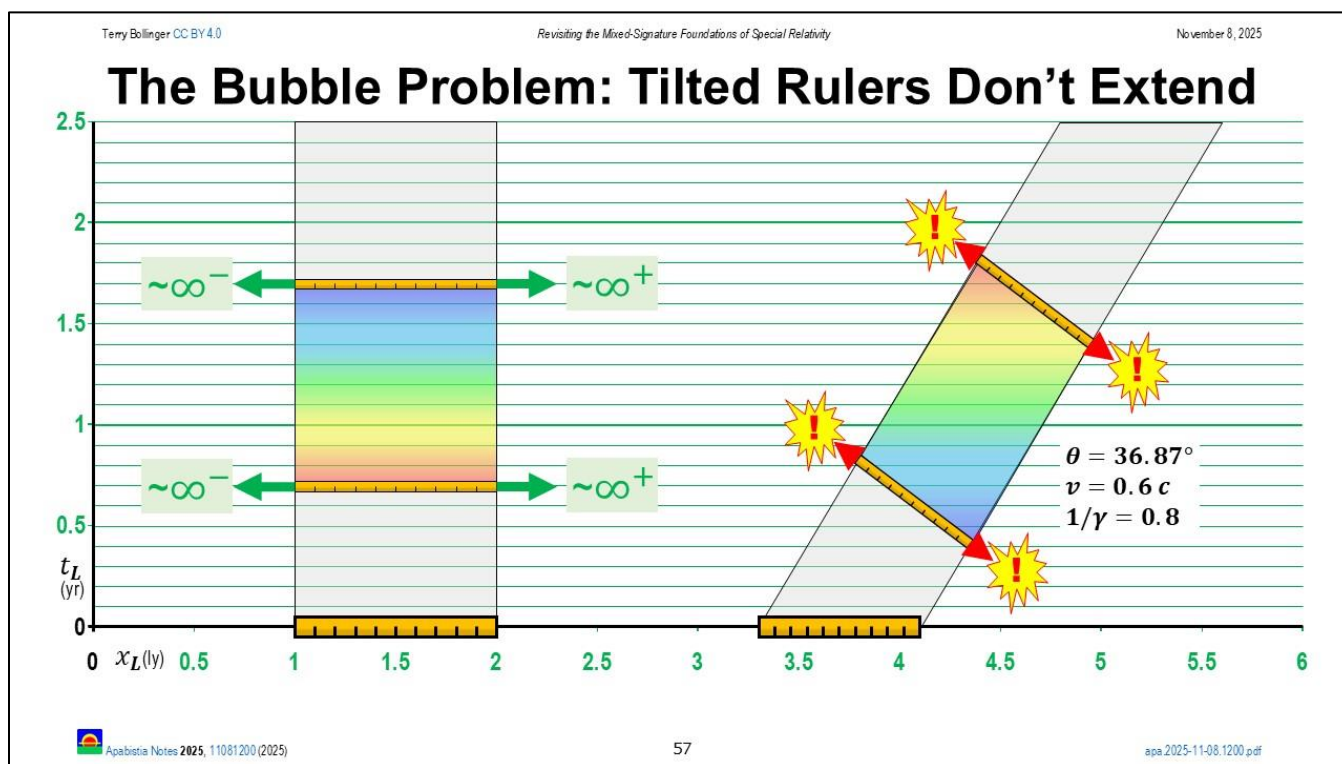


[1:12:04] Now, let's go back to those Poincaré bubbles.

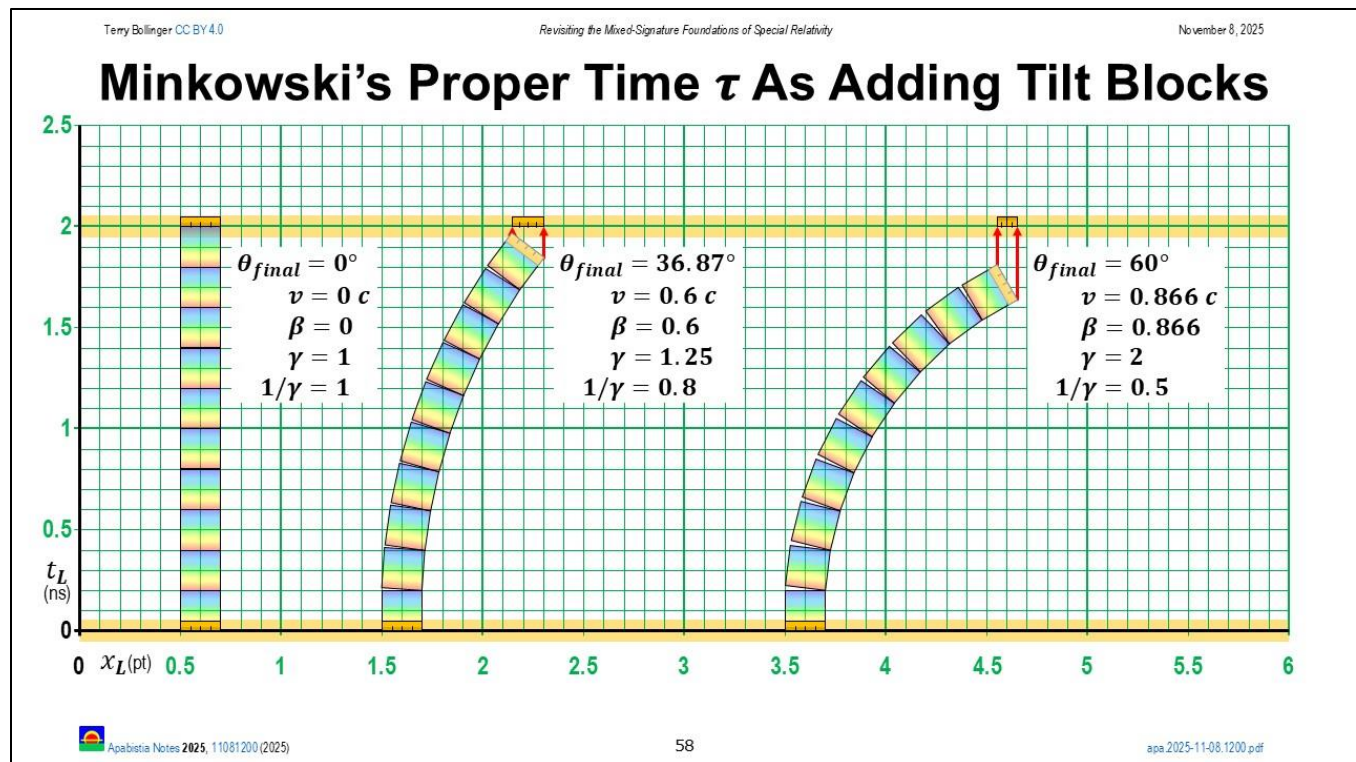


[1:12:09] If you're using these time blocks, you can use them to create these Poincaré bubbles. That's what a Poincaré bubble is. It's just one of these tilted blocks. You have a *finite* definition. That's why it creates a bubble, because you have a finite length. Every additional inch you go backwards has an additional energy cost and if you

go back for a very steep acceleration, and you go way back far you have a huge time and energy cost in order to do that. You have to *compress* the train. You have to reset all the clocks. You have to take... It takes *time* to do all this. It's *not* an instantaneous operation for a large object. So all of this are the dynamics of creating and setting up that initial frame and *then* you can do the acceleration. Then you get the figures where they come out with a simpler form of that. So, it's necessarily a bubble...

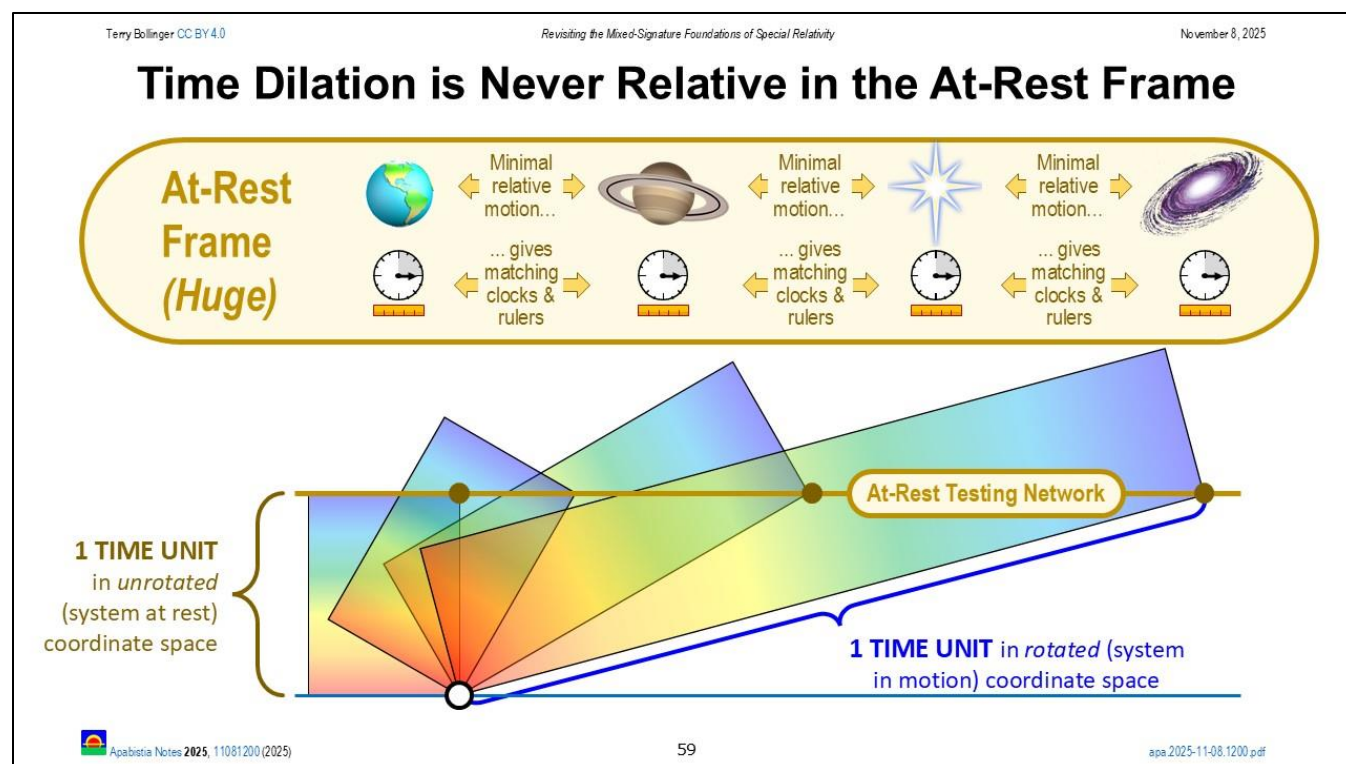


[1:13:06] ... because the metrics *inside* of that new system don't match the broader LAB coordinates that you were using. You have your own definition of shared we-are-not-moving-relative-to-each-other coordinates and those are fine and you can extend them infinity, they can go out to another galaxy, and you're... no problem. You can just say "As long as I know that galaxy's not moving fast compared to me I know it shares the same definition of time." All of that falls apart with these bubbles, because the bubbles, as soon as they get to the edge of the bubble, to the beginning, to the end of the train, everything's wrong. There's nothing to extend to. There's no object out there. You didn't pay the cost. You didn't pay the time. You didn't do all the incredible labor required to make your Poincaré bubble bigger. So, the bubbles have a cost. The bubbles have limits. The Poincaré symmetries have limits.



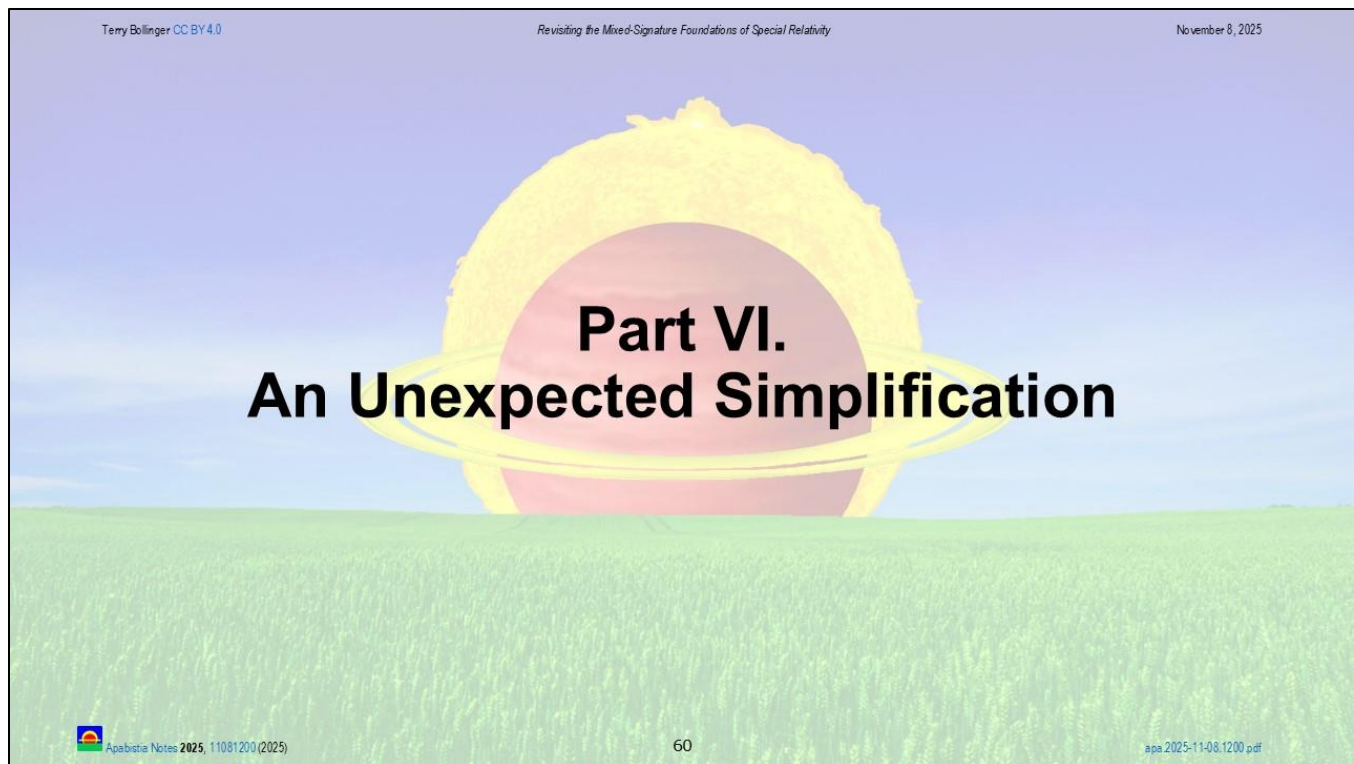
[1:14:05] Minkowski (!), had a version of finding what he called proper time, and he expressed it as an integration problem. Now, this one, I wanna... I want to hit this one kind of hard, because this is *very, very* confusing and is *not* telling you what's actually going on and there's just no other way to say this. I mean, it's just... I mean, [it'd be nice to say there's] another way to do it. There's *not* another way to do this. This is confusing the issue between acceleration as a stepwise process, which takes time, which is true... you know... you can't really do these instantaneous accelerations, but to confuse that with where the time dilation comes from has confused a *century* of students needlessly, because the simple truth is if you have a larger inertial frame and you have a smaller system hauling through it, *it will be time dilated*, because of the velocity. Every point you look at it at, you will see it as time-dilated. Again, this is not *my* derivation. That's *Einstein's* original derivation in 1911. That's where he *got* the idea from.

So, to say that it's the *acceleration* that does it is literally talking apples and oranges. The acceleration is a matter of how do you *figure out* what your final velocity is when you get to your cruising speed. So, [in] a proper model of that you will take these same blocks I've been talking about, shrink them down to the infinitesimal level, and make an integral out of the Euclidean tilted blocks. There's no need for the other spaces to do this. This is a safer approach and it simply gives you more predictivity. You can actually say *what* it will be at each stage *during* the acceleration. The acceleration itself, again, other than the fact that it changes the *tilt* of the block has *nothing* to do with the time dilation. So, that's a *very* confusing thing. It's thrown people off for literally a century.

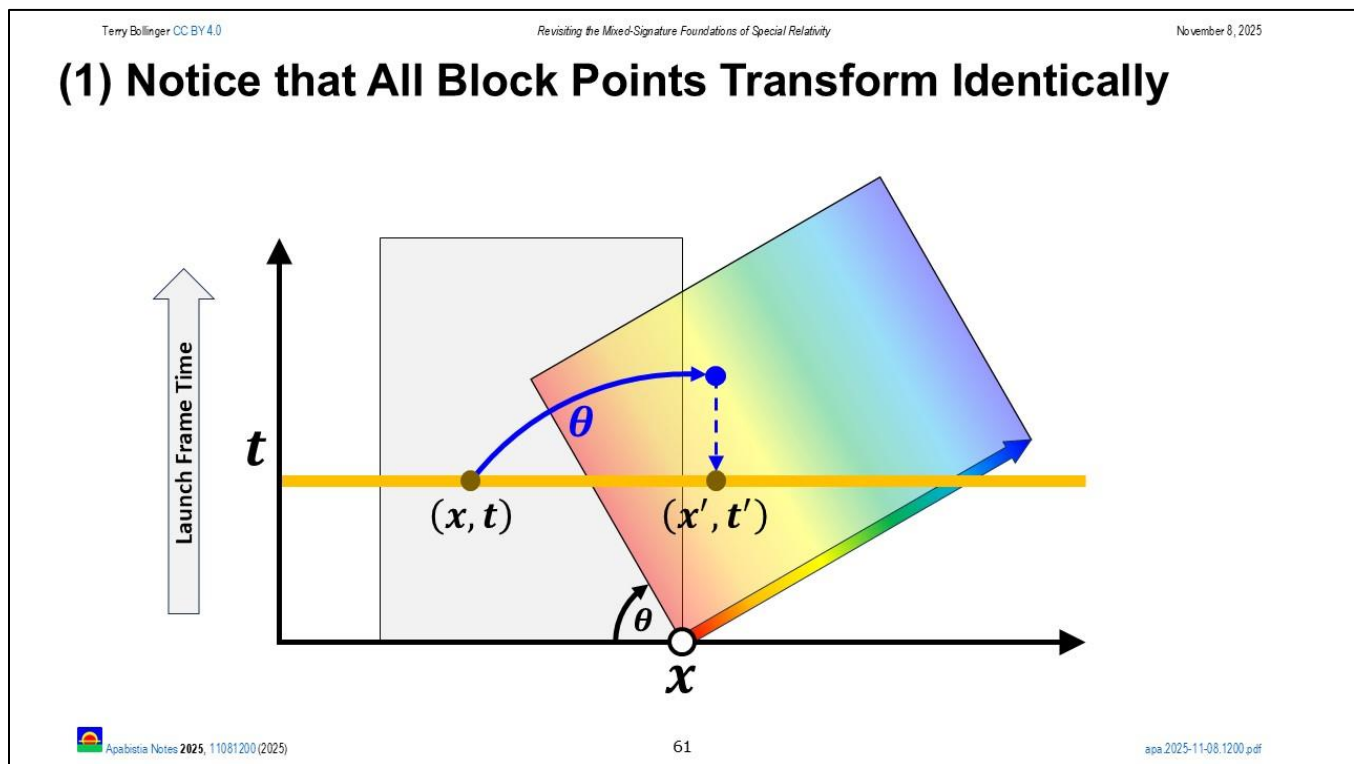


[1:16:07] I've mentioned that about time dilation always being there. Another way to express that: Every one of those blocks I've shown you... When you tilt these blocks, you *have* to keep them fixed in length. You know... because they show you the time that you're working with. However, if you want to *switch* perspectives ([e.g.] you want to go to say "Well, what's the view from *inside* of the block?") you have to do this: What you *do* is this: You have to get it to the point where the right-hand edge of that block finally hits the one-time unit in the master frame (in the larger frame) that it's embedded in, because then it will get the clock free and say "Oh, now I've reached one unit.", but in order to *do* that, it has to go through this *whole lengthy process* of *stretching* it out and you wind up having a *severely* time-dilated system.

So it takes a *very* long time for this system to travel to the point where it gets to that final point. So, you can't... The point being that time dilation is *deeply* intrinsic in this process of having accelerated these things. The viewpoint you have inside of the system is a much slower (a much [more] distended block) than you get from the outside.

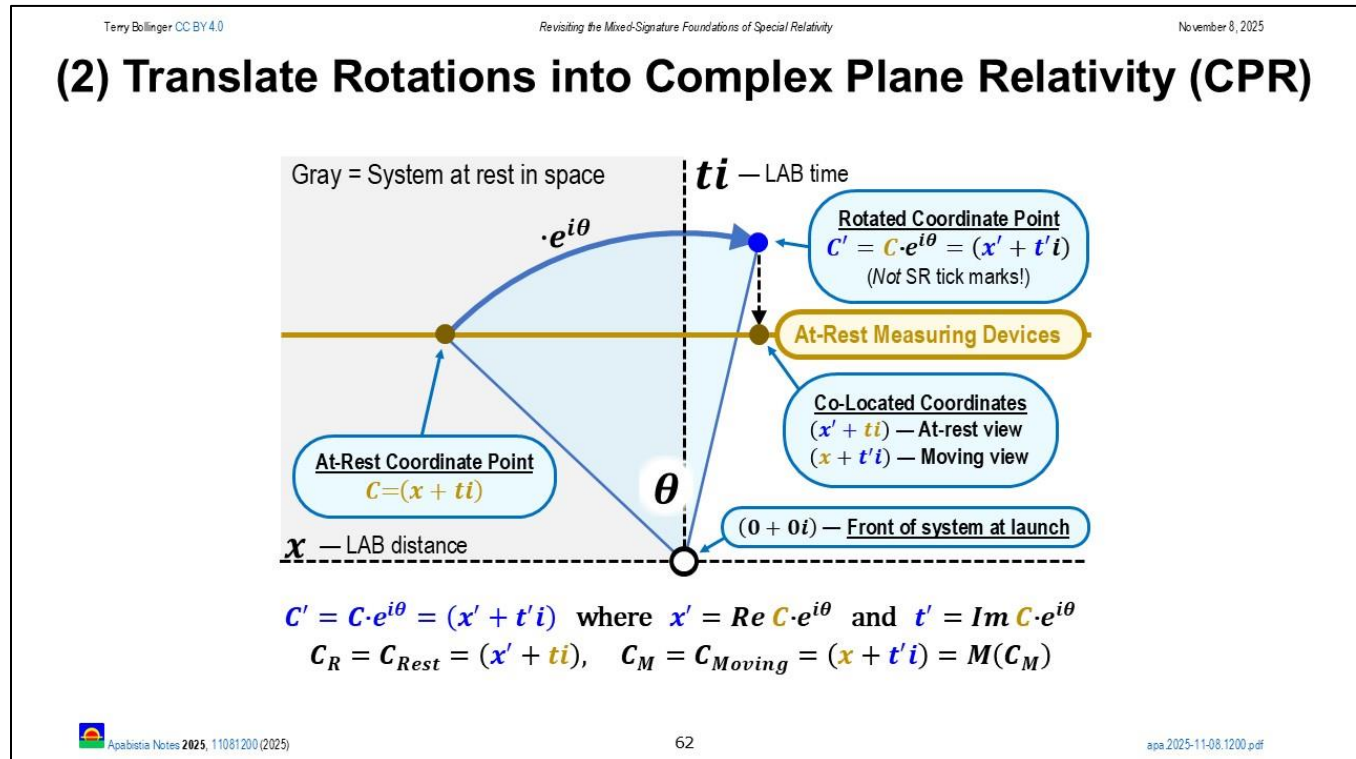


[1:17:26] Unexpected simplification... Wrapping this up:



[1:17:28] I was going through the tilted blocks. First, I already noticed that the tilted blocks... because of [those] orthogonal transformations by the same angle, you get the block. The block tilts. The tilt gives you, lo and behold,

all of the figures that you get from special relativity. I said “Well, what happens to *individual* points inside of that block?”. Well, then what you get is, of course, they’re just rotations, because you have invariant axes and two dimensions of doing that, so you’re just doing a rotation. Well, that’s interesting, so where does that lead?



[1:18:00] Where it leads is the same thing I led off with. The entirety of special relativity in Euclidean space, without Minkowski space, with careful attention to the acceleration process, and acknowledging that you have *device levels*... you know... from the rest frame. You have the master levels of the clocks that are *always* superposed on whatever it is that you’ve accelerated.

So, these timing and measurement systems *never* go away, but for the at-rest measuring devices you get a simple rotation, which if you use the notation of quantum mechanics is a *multiplication* by a rotation number, by a unit number conveniently represented by $e^{i\theta}$, one of those little magical things about exponentials of imaginaries. It’s just a *lovely* piece of math, that, and that’s it. You find the point... and I went through several examples and said “Well, it’s got to be more complicated than that, like those blocks. There must be some more complexity, there must be some more something.” *and it isn’t*.

If you start this from the rest frame, you get the tilts that you need in order to set the device into motion. If you do it much later, you get the final velocity destination... the final destination of the object with the correct clock settings. Basically, you just get all the information that you need, and you find out that all those clock settings are really just a function of your location in the original master space that you launched from. So, this figure means something, and I’m not sure exactly where it’s gonna go, but I’ve certainly had... a level of surprise at the simplicity of this figure. I just... I was gonna say, my first reaction was... The other one was a *eureka* feeling when I saw the tilted blocks. This was more like... It *can’t* be that simple and yet it is, because this is more predictive than the other ones and simpler.

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Revisiting the Mixed-Signature Foundations of Special Relativity
November 8, 2025

Conclusions

- It's time for a new approach: **Complex Plane Relativity**
- CPR **calculates all frame interactions** (no “mysteries”)
- CPR enables new views of space and time by treating them as **emergent matter-and-energy relationships**
- CPR *calculates*, rather than ignores, the strict conditions required to **set up fully working inertial frames**
- The **drastic drop in complexity** — one multiplication — argues that this approach is closer to how physics does it
- CPR suggests immediate **quantum theory connections**

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[1:20:08] Conclusions...

I am recommending an idea that I'm calling complex plane relativity, because it works well and it works simply and it treats space and time as emergent relationships, and that's almost a... I think we're *so* used to thinking of space and time as a fundamental fabric from which everything else pops. This is just a *wildly* heretical concept, *but* from an experimental viewpoint? There's *nothing* radical about this. You measure things with matter. You measure things with energy. If you assume... you know... kind of break out of the mode a little bit and say “Oh, so maybe matter and energy have their own set of internal relationships with each other, and those relationships *express* as multiple scale instances of space and time, always constrained to follow certain limits of how they were set up.”.

What's wrong with that? And the answer is it works very well, but if you do that it drops space and time down to an emergent level. They are no longer the fundamentals. The fundamentals are popping out of the way that matter and in particular fermions... I can get very specific about the way that *fermions* work and the way that they, interact with each other. It's not a coincidence that rulers and clocks are both made out of fermions, and if you can drop back and be willing to accept the premise that “Oh, maybe we should be looking a little closer at the standard model of particle physics.” (which is an *amazing* work) that we might get some hints and clues about how some of this other stuff works, and the final point is the drop in complexity when spatial relativity boils down to a single multiplication and that multiplication is merely a rotation, then you're getting closer to how the universe does it.

I don't think you need to have all the added complexity, that you can easily insert [into] it, but it argues powerfully that we need to be looking for simpler ways of representing some of these issues, and of course there's the issue about quantum theory connections. I in particular like the idea that maybe what we think of as velocity and acceleration and all these *large-scale* classical things are, in a sense, large-scale implementations of things that are actually quite quantum in nature, that they're involving the same rotations, the same kind of gauge theories that you have in particle physics, and with that, I will call it a wrap and stop sharing.



Questions and Answers from after the presentation:

TX = Team OrionX (Helen Ma)

TB = Terry Bollinger

RB = Robert E. Becker

RS = Ron Schreiner

BR = Berend Rah

CP = Caetano Peng

JL = Jin Da Li (zoom user)

[1:23:23] RB: Terry, I put some questions on the chat. I don't seem to have a... one of those raise-hands icons on my Zoom, so I put them in chat. This was quite a remarkable *tour de force* here and not just this session but also going back a few of your lectures that I attended, starting with examining the origins of geometry itself and working from that all the way up through *this* is a remarkable intellectual achievement. Even if all of this is *wrong* that's still a remarkable intellectual achievement. Have you ever... have you, well, before I get to my question... Have you published any of this theory?

[1:24:06] TB: No, most of what I've done (the part about the tilted blocks in particular) was only really a few weeks ago. The formalism about the complex plane implementation of the tilted blocks was maybe a couple weeks ago, and—

[1:24:26] RB: We're seeing this *live*. This is almost over—

[1:24:29] TB: Absolutely. No, when EttanEhsan... [They] nicely offered to provide some videos so people get a *visual* feel for what's going on, and again I can't emphasize this enough. These are simple [mathematical

concepts]. So, even though it seems radical in the sense that it's a very different approach, it's *not* radical in terms of actually trying out the examples and saying "What do you get?"

[1:24:54] RB: Well, it may have profound implications, if we were correct, because a lot of that simple math of special relativity, even leading into general relativity, ties into extremely *sophisticated* math—

[1:25:06] TB: Yes. Yes, that's what I think is *intriguing*, because I'm sitting here noodling around with algebraic equations and I'm not pretending to be some of the guys who are doing the super math and some of the larger scales in this, but I'm seeing the examples... the example I gave here... How do you deal with acceleration? Well, if you phrase acceleration in terms of these tilted blocks or actually more precisely these complex rotations, it just gives you a whole different *way* to approach the mathematics of acceleration. It produces a different perspective in how you analyze large spatially complex systems, and it gives you... and the other thing is it's a simpler method that gives you *more* predictive detail.

I *can't* emphasize that enough. If you... I mentioned earlier in the talk that when Einstein gave his example of the extended train, where he had the train that was going all... you know... very long, moving very fast, he did something extremely *uncharacteristic* of Einstein. [It's that] he didn't put a clock on the front and he didn't put a clock on the back, and he put clocks *everywhere*, and I've gone over that multiple times and I looked and I said, "Why did he not put a clock there?", and with considerable precision I can say the reason he did is because when he inadvertently coerced the origins of the reference frame and the accelerated frame to be the same point what he did was he created a paradox that he could not get out of.

He could no longer state which end of the train had what time. It wasn't he could... he could detect... he *knew* what the slope was. He knew what the slope was. He knew what the difference of time [was], but he couldn't figure out how to *relate* it back to the frame it came from and if you can't do that... you know... it becomes very iffy and I always wondered (and I've mentioned this before in earlier talks), but I've talked about Einstein's missing homework and then I realized, no, it wasn't missing. He had the equation *right there* in his coordinate translations, but never exercised it, because he had a *very* subtle error that kept him from figuring out how to attach it. You couldn't *attach* across the frames.

So, the reason I think that this simpler method will have some powerful implications for a *lot* of mathematical models, and *oh* especially general relativity... I'm just... That could be *fun*. That could be *fun*. So, it... because you take this new method, and all of a sudden those things become very specific. The train problem... I can give you exactly, for a given set of numbers, the numbers that should be on Einstein's train, and Einstein couldn't do that. So that says that [there's] something about this method that's a little more specific than that. Some of the issues we get with GPS satellites... Again, these are real engineering situations. These are not just abstractions.

GPS satellites, I would argue, for instance, like, starting now, that GPS satellites, if they start taking the perspective that there is a universal *Euclidean* framework in which all the satellites exist, which they can track. You could actually set up a little timer and say "Okay, I know I'm going at one half the speed of light." Good luck on that. The GPS satellites are still fast enough though. We have to take those into account, but if... you know... they're going fast, they could still keep track of the time that they came from, and you will never get a time paradox. This is, again, *very much* like the embedded vertical—

[1:28:45] RB: That was actually one of my *questions*. I worked briefly on GPS receivers many decades ago and my recollection is that in order for the GPS system to work you *must* account for general relativity. You cannot... You cannot ignore general relativity. That's one of the few systems (engineering systems) where general relativity *must* be introduced in order to actually have a functioning ordinary system, even on Earth or near Earth, but my impression from what you've described is that there's some... that that was done invalidly... that that's invalid the way that was done, that there were corrections—... I'm not quite sure I could follow on that.



[1:29:25] TB: No, it's not invalid, and I want to emphasize that. For instance, the methods... They've got *marvelous* methods for setting the times of the satellites. What I'm suggesting is that there are *simpler* methods, that there are actually frameworks in which you can convert some of what they're doing now into a *Euclidean* frame. Now, you mentioned general relativity. I have *not* touched general relativity intentionally. I'm not going to on this one. I'm talking about flat space instances where I'm talking—

[1:29:52] RB: You're saying that your methods would actually succeed in getting the proper time synchronization with satellites *without* having to resort to general relativity, which basically consists of the—

[1:30:03] TB: No, nope, no. No, I'm not saying that. [{sound cuts out}]... didn't realize what was going on. To get back to the one question, everything that I have done *does not* address general relativity. I am... Everything I've said here is for Euclidean flat space in which the level of curvature of the space is insignificant, and within that framework it doesn't... It doesn't change the predictions that you have, but it *does* add specificity about how, for instance, you would *accelerate* a new satellite system to enter into a different definition of space-time coordinates, and that is something that you probably could *use* as a useful tool on structuring satellite systems, on ordering satellite systems, and I don't know... I haven't done a deep literature search on how exactly they handle some of those problems.

The part about general relativity, and that you *have* to take in general relativity into account... You will not get correct GPS satellites if you do, and in *no* way am I suggesting that this method fixes that because it doesn't. The general... The space curvature issue is *there*, but what I *am* saying is that I think this would be a *really* interesting way to analyze (and something I will be addressing in a later talk) the general relativity issue, because if space-time is a construction of relationships between material objects, each with a finite scope, then there's no way that's not going to impact general relativity in some extremely interesting way.

The first approximation will be *general relativity*, and it'll be a very good approximation. So this is not incompatible with general relativity *at all*. This is just saying that when you get to certain scales (for instance, cosmic fabrics, cosmic filaments) *there* I would assert that if... General relativity... We think of it as having been perfectly predictive at all scales and in terms... when you add in the issue about dark matter, dark energy, cosmic filamentary structuring, these gigantic structures at huge scales, the assertion that general relativity predicted all these is *just not true*. It just *didn't*. *None* of this was predicted. All of this is data-driven.

[1:32:34] RB: Well, it wouldn't be general relativity by itself. I'm not aware... Well, there have been a lot of studies trying to show where general relativity may be contradicted or superseded by those discoveries, which have not to the best of my knowledge... have not succeeded yet in achieving that, but I wouldn't say they're trying to use general relativity *alone* to predict all of that.

[1:32:58] TB: Well, and I'm dating myself. I go back to the rosy predictions of when I was in college, in which everybody thought (*very firmly* thought) that the large-scale cosmos would be nicely homogeneous in structure and everybody was *so* surprised. Everybody was *so* surprised when it *didn't* turn out that way. That's what I meant by the original prediction of general relativity was of a highly homogeneous structure, and of course that observation *drastically* modified that.

Now, what I am suggesting, and I am having the audacity to say it, is that if space-time is structured as a series of complex gauge relationships... (I don't... I almost want to call them... but complex rotation relationships between material systems)... that's going to *look* like the same thing we have at many levels, but at some level it's gonna fall apart. It's gonna start looking different, *because* if the structure (the fabric of space-time) is a function, is an emergent property of matter, then when you get to *very, very* large scales, where matter becomes *very* sparse in comparison to the volumes involved, you will necessarily get new behaviors.

So, that's why I'm saying... [it's] that this is where I think it would be a *lot* of fun to explore some of these ideas in much more complex ways to see... Could this lead to predictions of what we call dark matter? Could this lead

to predictions of MOND [(Modified Newtonian dynamics)]? And of course, you're never... The MOND thing never been resolved. That is one of those cases where the data fit is perplexingly good and yet the mechanism just kind of goes like, *what?* Why would it do that? So, there are issues that need to be addressed in this.

Another example I'd give where there could be a relevance: if you follow the model that I'm talking about... and again, it's just a... it's a very simple algebraic model. It's two— It's one multiplication. When you have a model that's just one multiplication, it's *not* very complicated, but if you follow it through it says that the energy of acceleration is never lost, that when you accelerate an object, you have created a true excited state, just like we have an excited atom.

When you excite an atom, it has more energy and it has more mass. So this would say that excited systems, even if internally they can't see it, externally at the universal gravitational level they should exert that same energy that they contain. So a spaceship going at half the speed of light should show the literal relativistic mass (is the old term, because this concept has been kicked around back and forth in both directions for, gosh, for decades), but this would be a—

[1:35:48] RB: You don't... You don't assume, accelerations are instantaneous, *correct?*

[1:35:53] TB: Well, actually on the... I think the nature of acceleration *has* to be explored more carefully, because if you're talking about particle physics the accelerations are close to instantaneous. If you go anything beyond that of course you have to use an integral... an integration method, and that one slide of what I was saying is the integration method though needs to address this more in terms of these simpler operations, rather than just assuming... There's been a *lot* of confusion about acceleration *causing* time dilation. You see these... Oh gosh, I've seen entire YouTube videos devoted to the idea that when you turn around that somehow that moves your clocks backwards in time, and that's not what's going on. We don't see that experimentally. We don't see that observationally. It's a misunderstanding—

[1:36:41] RB: We *do* know experimentally that acceleration is *not* instantaneous with things like, for example, photo-ionized electrons. It's extremely short, but it is finite, at the attosecond level, hundreds of attoseconds level.

[1:36:57] TB: Yeah, and the nature of... Acceleration... If you've gone to some of my other presentations, one of the things that I'm pretty adamant about is that acceleration is the... kind of the definition of observation in that observation starts *bottom up*. So if you have a force and it accelerates something, that reduces its quantum state. Whatever you want to call it, the wave interpretation no longer applies, and I have an excruciatingly simple definition of observation, which is if you bump it you accelerated it and any wave function you had collapsed.

Why would I say that? Because *that* is what we see! The systems that are state quantum are the ones that you don't bump. The ones that are very cold, the ones that we keep stable, the one that we use various forms of transparency, like optical transparency, to *keep* from bumping the photons: those are the systems that stay quantum.

So, if you take that simply, it says that bumping is pretty fundamental and guess what? Acceleration is the operation that we're talking about. So, I think there just needs to be a deeper dive into the nature of acceleration. How long it takes is not instantaneous, and what its impact are on other systems, especially at the quantum level... So... Now, for *large* objects, it is of course absurd. You cannot take a spaceship and accelerate it to 86.6% of light speed without destroying everything in it, but the reason why the model is handy is that you can go *extremely* close to it, and then focus on the glide phase to see what the glide phase effects are on time and space, and if the glide phase effects on time and space are universal, which I would assert that they are, then you have a better understanding of time and space at that point.

What we *don't* have a sufficient understanding of is the acceleration issue, and I just think... Like I said, acceleration is not just a second derivative of velocity. Acceleration is... seems to be something profound and



related to both quantum and relativistic theory. So, yeah, I just think there are interesting avenues for exploration. In terms of the integration method, I'd go back to that one slide where I said you just have *very, very* small units of the... tilted blocks is the easiest way to visualize them, and take them small enough where you can do the classic smoothing and assume that the acceleration is instantaneous within that context.

As far as I can tell... and again, this is new enough, I haven't had time to do that. It's one of... that's one of the things on my agenda, [it's to] do the acceleration integral using the complex plane relativity. I think that'll be fun. I think that'll be an interesting integral, and that would give a better model for realistic acceleration.

[1:40:22] RB: I had about two or three more questions, but I've been hogging all the time. I noticed on chat Ron Schreiner had a question. Why don't I back out and then let him ask his question and then if you have time I'll ask my other three. They're in chat, but let me not hog everybody's time.

[1:40:40] TB: Okay.

[1:40:42] TX: Yeah, sure, let's answer Ron's question. Is Ron on there?

[1:40:47] RS: Yeah, actually, you kind of talked about it a little bit. It's like... Yeah, this concept of a super long train, I guess for the purpose of your analysis you're assuming that the entire train is all moving at the same speed, that there's no issue with this propagation of acceleration, and if I understand this correctly (and I may not) an observer in the *first* car will notice that when they observed the *last* car it'll be in a different time reference, maybe even moving at a different speed? Is that?—

TB: Oh.

RS: [{laughs}]

[1:41:29] TB: Two questions, two things to address: One of the reasons why I like to use the satellite example instead of the train example is because whole papers (I think whole books) have been written about acceleration propagation and how the forces... Actually, I've seen some quite fascinating papers about the propagation of the forces in those cases, but *that's* not what I'm talking about and that's why I want to be careful in that.

RS: Okay.

[1:41:56] TB: To use the satellite case, what I'm talking about is you *move* the satellites close together, you could have a thousand of them... You move them close together and you accelerate them all *individually* to exactly the same speed, which you can predict, that after those systems have had enough time to communicate with each other, which does take some time, depending on how long it is, they will see each other at the same instant in time. So what you... The other part of the question you're asking is, no, this works the other way around. When you have the guy *in front* is at a different time from the guy *behind* that is what *we* would see looking at the train.

RS: Oh, right.

TB: What the guy *inside* the train sees is *simultaneity*, and again *that* part's not radical, that actually is exactly what I... That *is* Einstein's train example. The only difference is that Einstein didn't attach numbers to it. He said that, yeah, they're going to be non-simultaneity, but he didn't give an attachment point. He didn't give a way to calculate the exact difference on that, and what he... by... Unfortunately, by *not* doing that it promoted an *overly mystical* viewpoint of special relativity and this I think is just unfortunate, because since he *didn't* give an answer, people just kind of went off in a *hundred* different directions and... you know... talked about whether there was a different definition of the past, a causality.

If you go back to *Euclidean* framework, and this is one of the reasons why I emphasize the importance of the Euclidean coordinate hierarchy, you never get causality violations. You never get *weird* violations of time. That's why I was so adamant that when you extend the train, you *have* to extend it from the front *backwards*. If you do anything else, you need... because you have to tilt that back part upwards, in terms of the clocks of the *observer*, which is weird but it just... It's like time zones... you know... This is not that you're actually going... You're not *experiencing* that time. Somebody literally in the train or the satellite has to go back and crank the dial to a new setting and at the time he does it (before he accelerates) he says *why am I doing this?* But then the *moment* all of those satellites accelerate the same guy goes back and says "Oh, *that's* why I did that. Now I'm in sync.", and it's... you know... it's not intuitive to us.

It's *not* the kind of thing that sinks into our perception easily, because we don't *think* in terms of non-simultaneity. That's a *very* difficult mode of thought for us, and yet you can come up with very specific examples where that's exactly what they gotta do. They manually crank the top... No time paradox. Nobody's dipping backwards into time or something like that, and *that's* the problem that was created when Einstein didn't lock that down, is people started drifting off into all sorts of directions about... you know... maybe there's different realities if you're in a different frame. It's *fun*! It's... you know... the sound of one hand clapping, the idea of contemplating something that you can't quite get a handle on what the answer is, but it *doesn't* move it forward. It doesn't... you know... get us to the next stage on what we're doing with that.

So, yeah, the train... but inside the train? They'll see each other as simultaneous and they—

[1:45:26] RS: Ah, thanks. Actually, for me, the satellite example is more easy to understand, so thanks a lot.

[1:45:36] TB: Yeah, I *do* prefer that one because like I say the trains... You get into so many other issues, but *satellites*? If you really want to do it... you know... you gotta move them independently.

There were some other questions?

[1:45:52] RB: Well, you got my other *three* if nobody else has any.

[{non-distinct chatter among multiple people}]

TB: Daniel, did you have a question?

[1:46:02] CP: I said I have a quick one. It's very quick. Terry, have you had a chance to verify your approach with other approaches and some validation with practical cases?

[1:46:18] TB: With *who*?

CP: I'll say—

[1:46:18] TB: Oh, practical cases. This is, as I mentioned earlier, it's kind of in real time, so there should be existing information out there, especially in satellite systems, that would either confirm or deny some of the stuff I'm saying. It would just be a matter of looking at it from a different viewpoint. In other words, take the same data they have and say "Well, what if we analyzed it from a Euclidean framework perspective? What do we get?", and my *assertion* (my prediction) would be that it works fine.

You get the same result, or in some cases you might get a more *specific* result, something that you thought was an experimental factor, you would say "Oh, I can predict that after all, because that would simply be the following, time slope gradient against the front of the same satellite system and all of a sudden you have a *very* specific prediction about what you *have* or what you *need*, and I *do* think there's some practical uses for this in satellite

systems, I really do, but I haven't had a chance to explore any of that and also I'm kind of itching to look at some of the general relativity aspects of this. It would be... could be interesting.

CP: Yeah, thank you.

TB: Thank you.

[1:47:45] RB: Okay. I'll try to go through this quickly. We're getting late in the game here, but what I'd ask in the first question is you would... Even later on, you would mention that... and this is from earlier in the lecture here... you would mention that matter (rather: space-time) is emergent from matter. Now, there are modern theories as you probably know where space-time is emergent, although usually that's from information. In an information theoretic framework, interpreting information as being more fundamental than basically space-time and also thereby tying that into things like entanglement, which can be derived *out* of that, but in your conception matter seems to have primacy and so my question was is matter in that sense *privileged* over fields and energy?

Is... How do... In general relativity of course matter and energy are *combined* into a stress-energy tensor. They're really *not* independent concepts. Neither are fields. So, in your construction, how are matter, fields, and energy subdivided, combined, merged, and fused together? Is there any distinction between them? And then I also asked in this question, like, is there any location in your formulation or conception, is there any location in the universe that *can* be completely free if not of matter than of fields or even more fundamentally energy? In other words, can the universe exist without matter or can any part of the universe exist without matter, or energy, or fields?

[1:49:30] TB: Okay, I think— [{laughs}]

RB: It's an easy question. [(jokingly)]

TB: I think I may have lost the bubble on the first part of the question. Let's see, uh—

RB: Well, it is in chat. If that's easier, I can repeat it, but...

[1:49:47] TB: The first... Let me address one thing. You mentioned about information, about space-time being emergent, and information being more fundamental. I did want to make a quick comment on that. It's that I would propose almost the opposite. I would say that information is the *most emergent* of all quantities and is the basis of space and time.

So, in a sense that *doesn't* disagree with that, but I would see... I would be *very* careful about saying that information is more fundamental. I would say that the *emergence* of information is the key event that enabled the definition of space and time, because if you think about it *what is space and time?* Space and time is where we can... where we can put information into an array and then we can progress it over time. The two have an *incredibly* tight relationship. You can't have functionality if you don't have memory. You can't have memory if you don't have persistence. You have to have these *relationships* that we would generally refer to as information.

So, one of my common phrases is that information is the *greatest emergent effect* of the underlying physics. It's the one that makes classical physics possible. I would also say that [classical physics (even more bluntly)] is just the most *marvelous* emergent concept imaginable, because without classical physics, you don't... Classical physics and information are two sides of the same coin. The fact that we have these structured, persistent things *is* because that physics got to some point where suddenly this idea of persistent information could survive long enough to make things interesting, and saying that persistent information lasts a long time is *identical* to saying that *time* was created, because you can't define time without persistent information.

So these have a *really* nice relationship in terms of whether you can have empty space... There has to be something I... and this is one I've gone through in some other presentations, but actually maybe that's an



upcoming presentation. Roger Penrose has this idea of his cyclic, and I can never remember the [name]... CCC (Cyclic Conformal Cosmology)? It's an idea of scale invariance.

[1:52:15] RB: I think I've heard of that. Yeah.

TB: Yeah.

[1:52:17] RB: By the way, I'm sympathetic with your... very sympathetic with your idea of information being emergent from... being the emergent quantity rather than the reverse, but that would be very heretical today.

[1:52:29] TB: [{laughs}] which is *why* I get so grumpy about the approaches. Keep in mind, I'm a firm believer that quantum computing is not only real, but it's just... I think it's important for life, for instance. I think our individual *molecules* are structured in such a way that *they* use quantum mechanics in a way that we don't understand, *still*, and it makes them seem like they just magically make the right decision and in scales that we would have a *very* hard time doing with computers, and that's just individual molecules and I think that is... That is the real power of quantum computing there.

My problem, my beef, is that as long as we talk about qubits, which was, again, this was the same thing I'd say about... you know... innocent mistakes. It's *so* easy to say that "Well, obviously the simplest thing is a 1 or a 0.", and so then we should quantify that. I think that actually made quantum computing *enormously* harder, because look at my earlier statement, quantum... I would say bits are the *most* classical concept in the universe. The more solid the bit is, the more matter is involved, the more that you have coordination to keep that bit *solid*. That's your... Bits are your definition of time. They're the ones that is the emerging quantity that allow us to have this interesting universe.

So, I think they went in the wrong direction. They tried to take the most *classical* thing and give it a *tiny* bit of quantum behavior, and whatever's going on I think is a little more deeper than that. In terms of the particles, you asked about energy versus matter. Fermions!... Oh, I just can't get away from a subset of fermions. The rest mass fermions... What is rest mass? Rest mass is the *ability* to go through time without moving in space. Hmm...

If you don't have a concept of rest mass everything becomes scale-free. These ornery little things called fermions. They just sit there and say "You know what, *I've* decided I can just sit here in time and just circle around and around, and I don't have to move.". So, photons can't do that. Even the quarks, arguably, can't do that except in groups, because the quarks always are in motion *unless* they're bound to each other in it, like a proton or a neutron.

So, it's quite possible the only fermion that *truly* captures this concept of rest mass all by itself is the electron, and then you have the combination of the quarks and thank goodness we have those two combinations that together give us *hydrogen atoms*! Then you're trucking, *then* you're starting to talk about time. So yeah, I think there's a profound distinction between these just... free energy and the concept of fermionic mass, this idea of the half-spin... That is a *deep* mystery, what this half-spin thing is about, but it's clearly associated with this idea of the ability to stay stable in time, and I don't think we're at the... I don't think we poked *nearly* hard enough at what's going on with that, because I think that's part of how time winds up being created, how time and space is emerging from these fermionic interactions, and I've quite forgotten your other questions, I think.

[1:55:59] RB: Well, the first... I didn't get to those yet. You answered the second part of the first question and about the vacuum as to whether anything could or could not be in the universe. Don't answer. I'm just... Just for food for *your* thought, is the distinction if any between matter, energy, and fields and how that ties into your conception of emergency if any from... of what's... let's say geometry from matter. Should it be from geometry from matter? Should it be from geometry from matter energy? Should it be from geometry from matter-energy fields? And given that fields (most fields that we know about) at least in terms of propagating waves

(electromagnetic fields, for example) are in theory, and gravitational... are in theory infinitely distant. They are not short-ranged fields, then in principle there is no spot in the universe that should be without such fields present.

In other words, no true vacuum, with no fields whatsoever, from *any* possible source, as long as there's sources in the universe... So, my question fundamentally was what does that mean for your conception and your... of your... that you just went through today? Particularly the part about geometry essentially being emergent from matter. So, no need to answer that right now, just maybe some food for thought. That's what I was directing at there. My second question concerned maybe something a little bit similar to that. You... In terms of the CPR, your CPR, and inertial frames there is mention of points.

Now, if I recall from your previous lectures, and I may be recalling this incorrectly, you had a certain problem with the concept of a point, okay? But my point, *my point* (pun intended) is that in modern conceptions of things like inertial frames it's usually posed in terms of differential geometry in terms of things like fiber bundles, and when you do that generally speaking you have like a fiber, which is a group, and then you have something... in the simplest case, you have something like a tangent space where these kind of... where these frames would... like a moving frame, like our time-moving frame would live or in that case would actually be the not... the cotangent space, and then... but the point is that they *live* above (if you think of it that way, if you picture what a fiber bundle is)... they live above a base manifold and the base manifold has points. So, my question basically is is *your* use of the concept of frames consistent *without* points, if one wants to think of it that way, consistent with let's say differential geometric interpretations of the same concept of frames?

[\[1:58:49\]](#) TB: Wow. In terms of the points, I would say that you *do* need a point-like concept. Whenever I use the word point you can just automatically assume that I mean an asymptotic limit that approaches a point. I'm never talking about a true point, because they don't exist in the physical universe. They're infinitely energetic. However, if you don't have a concept of asymptotically *approachable* points, then you... a lot of the math, you just... you can't get the emerging complexity that you need that you mentioned, like in why those fiber bundles work.

So, I would *not* reject the idea that there are point-like constructs. What I would do is I would kind of strangle their infinite resolution down to a much more pointed, much more finite, set of definitions. Anytime that the mathematics starts going off in the direction of infinite numbers of fibers, bundles, points, I would literally take that as an indication that you're *probably* getting away from the actual generative process for those interactions, and what you should do is constrain it and go back and say "Well, given the finite amount of mass and energy involved in this particular situation, what is the most elegant model of that class that you were just talking about that describes this situation?", and what I *think* would happen is that you would find some of the math would simplify. That you'd say like "Oh, by the time I get down to an individual particle... Oh, that's interesting. The only thing left is this one rotational self-observational spin characteristic (spin being something very important in all this), that when a particle starts spinning it enables the capability to persist and start moving in other directions and forming more complexity."

So... A lot of the models, I think... Physics has *so* many *really* good and powerful models. So, the idea is always to say "Well, can the model be *simpler*?", not whether the... Too often people say is the model wrong or something? That's the wrong question. The question is, can the model be simpler? And I think in some cases there *are* some simplicities in that.

My perspective on black holes are an example. I don't accept the idea as likely that there's a singularity at the center of a black hole. If I'm consistent with my own framework I *can't*, because the curvature of the black hole is created by matter. So, I would go to an event horizon level construct, which does *remarkably well* at predictions of the things we actually *see* since you can't see the singularity, but that would be an example where I say *pull back* on the math if it starts getting *infinitely dense* in information especially is a bad idea, because information is a *precious* quantity and needs to be kept in check. So...



[2:02:05] RB: Lloyd Motz would have liked you, or you'd have liked Lloyd Motz. Ever hear of him?

[2:02:10] TB: I'm sorry. Say that again?

[2:02:12] RB: He was an astrophysicist for many years, a professor of astrophysics at Columbia University, starting around mid-20th century and onwards. He basically almost rejected quantum electrodynamics on the grounds that he couldn't stand the infinities. He eventually sort of reconciled it with him, but he basically rejected QCD [(quantum chromodynamics)] and modern particle physics because he just said this "I will not accept the infinities."

Now, his are quantum field theory infinities, not the infinities you're talking about, but he... Yeah. You two would have had some interesting conversations. I *knew* him back from around 1970 and the... He's written some... He wrote many textbooks and popular books on astrophysics, but he had a... He actually tried to create... construct black hole models out of basically particles. He interpreted particles as *being* black holes, which actually has *revived* a little bit in modern times.

By the way, speaking of quantum field theory, as you may... You're probably aware. There is a *Euclidean* approach to quantum field theory, which usually runs into problems and so you have to throw in a *wick*— what's a *wick* rotation, W-I-C-K, to take care of that, but if you're doing an entirely Euclidean signature you might want to look into what that might do or might help quantum field theory in some situations.

[2:03:43] TB: Euclidean quantum field theory, what was the name again? Wick?

[2:03:47] RB: "Vic". It's spelled... Well, it's pronounced "vick", but it's... The famous physicist, 20th century physicist, W-I-C-K... It's called the wick [(“vick”)] rotation. It's a mathematical rotation that's used to eliminate some problems with the signature formalism at the base of what's called constructive quantum field theory.

[2:04:11] TB: ... and what was the first name you mentioned, who uh...

[2:04:14] RB: The man? The man that I mentioned? Lloyd Motz. M-O-T-Z?

[2:04:19] TB: Lloyd Motz. Yeah, I'll definitely look that up.

[2:04:24] RB: Not M-O-N-T-Z. M-O-T-Z.

[2:04:28] TB: Oh, M-O-T-Z. You know, he's not alone on being, skeptical about quantum *field* theory. Quantum electrodynamics, I *always* remember that... you know... You can find it on YouTube, but there's just this hilarious point where Feynman's talking to a room full of mathematicians at Princeton about *his own theory* that he got a Nobel Prize for and dismisses it as saying like all this energy going on in a cubic centimeter? That's probably something more like checkers, and I just *love* that quote, because he was... One of the things I like about Feynman is he did *not* have that much faith in his own theories. He always was looking back and saying *is that right?* And that was an example in that...

[2:05:18] RB: That's the *best approach* and of course what it *did* stimulate was the mathematicians starting in the 60s came out and actually started trying to formalize... First, the physicists developed the theory (Feynman and the others developed the theory) but then the mathematicians in the 60s sat down and figured out how to put that on a firm mathematical basis and that's where constructive quantum field theory came from. So that is... that's interesting. You really have to love the math in order to go through that. I've read a book on that, *egads*, but anyway that's one aspect.

Finally, my final question and I'll shut up for the day is: The... You mentioned in one of your slides, I think you called it a cooperating entity with regarding your *bubble* (the PB, the Poincaré bubble) that sort of *struck me* when

you said that in terms of the necessity for a cooperating entity and it suddenly struck me could that conceivably (in your construction) have any relationship to entanglement? Perhaps through some kind of what I would call like a substratum enabling this cooperation.

[2:06:30] TB: The substrata, the entanglement, the cooperating, the idea of cooperation and that... There is something *really, really* interesting going on underneath all this and, by the way, in one of your earlier comments, did I think that... you know... everything (matter) just came by... I think there was a... When I mentioned Roger Penrose's theory what I was going to suggest is... I have a presentation (it's out on my site somewhere)... but I suggested the idea of a cyclic by... a cyclic version of the universe that *grows* in complexity each time, that each version adds a little more elaboration, has the ability, and that those previous universes in fact are still with us. That we—

[2:07:15] RB: Well, that's interesting because there's certainly (as you're probably aware) been proposals for cyclic universes, one that grows in complexity... Well, actually, I'm wondering, that might be... I might have read of that... You think that's the Penrose idea, that there's basically a decreasing entropy or would it be—

[2:07:35] TB: I *could* not agree with this scaling idea for the same reason I think Sabine Hossenfelder mentioned nicely, but... She just... Protons just don't evaporate like that... you know... so his whole idea is that if you get to a certain point where the universe is infinitely smooth scale becomes irrelevant, and *that's* a good point, but these fermions just *don't* seem to want to cooperate with that, so the thing I had different about the idea of [a] cyclic universe was I'm a dual universe person. I believe that there is a... I think there's a very powerful structure, that you have full CPT [(charge, parity, and time reversal)] symmetry. which *requires* the existence of a Turok-type anti-verse and Turok's not the first one. [Carol?...] I think [Carol and Chin?] were the first one in recent times who came up with the dual universe idea, then Boyle and Turok have *certainly* expanded on it and I love some of their papers.

Some of the other papers about the heavy neutrinos, I'm unsure, but I think they're just doing some *fascinating* work, and good use of the math even if it is maybe over-complex in some points, but in a dual universe thing I use *that* to collapse the universe instead and... but with each collapse the idea is that you come back with another cycle of more complexity on top of that, and the nature of these additional complexities is in a sense not that complicated. If you look at something... look at a pion... you have these... this collection of forces that interact, that hold it together. You have electrical charge. You have color charges of three types. What *I* would suggest is that, no, in the earlier universe there was just one force. There was just *one* force and that's what bound that kind of a particle together, then in the *next* iteration of the universe you wind up with a little more complexity and *then* you start differentiating, but the differentiation... It comes from the context.

[2:09:30] RB: You basically... You punt the unified field back to a previous universe.

[2:09:35] TB: Right, yeah, and in fact where *we* cannot make a quantum distinction between the field types, the the strings, the *real* strings, not the—

[2:09:45] RB: It's supposed to be at high energy. It's the reason you... If you're high enough energy, then you *do* lose the distinction and the symmetry breaking is no longer there, but—

[2:09:55] TB: Yeah, what I'm suggesting—

[2:09:57] RB: Most theorists assume that's gonna be in *our* universe, not in a previous instance of the universe.

[2:10:02] TB: ... and what *I'm* suggesting though is kind of a much more low-energy approach on that. In the case, for instance, of a pion, that... the binding of the quarks to the pion... that what differentiates the forces is *not* high energy, anything like that, it's context. That if you don't have the right context, then the other forces are meaningless and it just goes back... That's why I say these other universes are still with us, when you cannot

make a quantum distinction between the different forces, such as the forces that bind quarks together, then you can make an argument that really those forces aren't differentiated, and I think if you take that instead of going to the high-energy path... contextual distinction between that... it's easier for a universe to grow in complexity because essentially you're just adding new layers.

You know, we do that in regular life... you know... Simple things become more complicated, but the context also adds more richness to what it is. I don't see any reason why that can't happen down... all the way down at the particle level, so that when we look at the standard model and say "Why are these things sort of like?...", but then they're different, and then they differentiate, and they differentiate some more. That, kind of a... Unity first and then *milder* (not high energy) but *milder* contexting allows that to be a more interesting and more robust universe, and I would kind of think that... you know... How we started...

So, it all has to begin somewhere, so presumably it begins from an extreme simplicity. I don't know *how* far back you can go, but... Simple pair production at least is a starting point, that you can have a thing and an anti-thing, and they pop into existence very briefly and then they go away, and *what is time?* Time is where those popping in and out got complex enough that they suddenly lost track of each other and said "Oh, where's my partner?". So, zooming off as two universes with opposite definitions of time. That is my own mental model, but it is a *nice* model just to understand things that otherwise look pretty cryptic, because your CPT symmetry just comes automatically from that, the idea of where time emerges is *deeply* tied to why we have hydrogen atoms.

Why did time emerge? Because *somehow* all these little things noodling around got to a point where they found out they could create a *positive* charge with 3 quarks and a *negative* charge with 1 electron and you put those two together and they don't quite cancel, and *that's* where you get time. That's where you get persistence. Once *that* happens, you get persistence, but look at the layers of complexity you have to go through to get there. You have to go through multiple layers of complexity. So, electron-positron is much simpler but that doesn't give you a universe. That doesn't give you time. So you have to have these more complicated *gnarly* relationships that emerge and I think that's where we get the complexity of the current universe.

Anyone else?

[2:13:16] RB: Oh, thank you for the discourse. I'm going to—

[2:13:18] TB: Oh, yeah, very interesting. Thank you for bringing up some of those people though. I'll definitely looked those up and I've looked at wick rotations... "vic" rotations; I'm pronouncing it wrong. Oh gosh... I remember finding them interesting at one time when I looked at them, but it's just... it's been a while, so I need to go back and take a look at that. So, thanks.

Anyone else?

Jin Da, I like your Thanksgiving icon. That's a good turkey and cornucopia there.

How long are we at? Are we at a wrap?

[2:14:16] TX: Yeah, we got a comment: "Thank you so much for another wonderful and informative talk." from Masha.

TB: Thank you, Masha.

[2:14:25] TX: So, do you have any other questions? "That's a wonderful discussion. Good day."

If not, we can... Yeah, go ahead, and Richard said thank you for an amazing presentation and Q&A.



[2:14:44] TB: Thanks everybody here.

[2:14:47] TX: Yeah.

TB: Thank you for all the questions. Very interesting.

[2:14:53] TX: [Juan] said great visual graphics, as usual.

[2:14:57] TB: You know, I'm gonna make a comment about the graphics. I see everybody using chatbots to create their graphics, and every time I see that I say do you *realize* what an opportunity you're missing? Because for me making a good graphic is *how I think*. I look at a graphic and I say, is that *really* what I meant to say? And then you look at it again and you say "No, this relationship's a little bit wrong." Focusing intently on a graphic is just... something that helps you stimulate you to see what you're doing.

If you have a chatbot summarize it for you: *guaranteed* you will not get any insights out of it. You'll just get a *bland* representation. It may be *pretty*, but it's not the *pretty* part that counts it's whether you look at it and say like "Is that what I meant to say?" and if I said it does it really make sense? So a little comment about my graphics... I *love* doing my own graphics. They are laborious. They're PowerPoint, but I think it's just a good thinking technique. So, thank you.

[2:16:04] TX: Yeah, he said there's a lot of things.

TB: [{indecipherable audio}], yes.

TX: [{indecipherable audio}]

[2:16:10] TB: ... but, you know, people don't realize that James Clerk Maxwell predicted the speed of light and nailed the fact that light was electromagnetic radiation by using *mechanical models*, and I *love* that. This was before differential equations. He used squirrely-looking little mechanical models of the magnetic electric fields and *using those* he was able to figure out that light was a form of electromagnetic radiation. So, master drafting and drawing carefully has some benefits and I think that relates back to the way the universe *works*, because these things are all related. There's a lot of depth in that.

And Robert, one last comment on whatever that underlying infrastructure is. *It* is interesting. It is... Quantum mechanics just *touches* the surface of it. It's wonkier than that, because quantum mechanics is waves and particles, and waves and particles are part of the *classical* universe. So, this unformed underlying universe... That... There's some opportunity to dig into some interesting ideas with relevant points and issues like quantum mechanics... like quantum computing.

Anybody else?

[2:17:30] RB: No, just thank you for, again, a very fascinating lecture.

[2:17:39] TB: Okay, I think we're at a wrap.

TX: Yes, and remember we will have another one at 4 p.m.—

TB: 4 o'clock.

TX: [{indecipherable audio}]. It's about generative AI from Dr. Luen.



[\[2:17:49\]](#) TB: Yes. I hope to make that. I'm not sure... As I told you, Helen, earlier, I'm not sure I can because I've got some schedule conflicts, but I really hope I'll be able to make it, so...

[\[2:17:58\]](#) TX: ... but we'll do the recording like this.

TB: I'll take a look at it then, if not. So, thanks.

TX: Yeah. See you next time and soon next month.

TB: Next month.

TX: Thank you. Bye.

