Einstein and the Mystery of My-Train-Only Time Dilation

Terry Bollinger
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An Entirely Fictional Story with an Entirely Real Math Conclusion

I want to tell you a story. It is a story I never included in my books and papers, for my hosts asked me never to divulge it during my time here on earth. The secrecy is due not to the story's outcome, but the tightly held secrets of the methods used — secrets never explained to me. Thus I cannot and would not reveal those secrets even after I am gone. However, I can finally reveal the results to those reading these words.

I am famous for many things, but one insight I value especially highly is the intransigence of the speed of light. It provides more than a limit, as it gives us insights into the nearly insurmountable barriers to traveling *near* the speed of light. No one knew these barriers before; they transform how we perceive physics and the cosmos. So formidable is this limit that only the smallest particles can approach it. Thus my theory of Special Relativity, despite its almost limitless plethora of successes and proofs at the particle level, remains incompletely tested at the human level. The cost of such as test in terms of energy is too high, and the methods for achieving it are unknown.

The secret I do not know and so cannot reveal is how the United States Air Force found a way to *bypass* these limits and provide, as they described it to me, a way to explore such domains without actually reaching them — a leveraging of ordinary, mundane speeds and velocities to achieve the unobtainable, at least in terms of observation.

I have received innumerable invitations during my long life, but none so strange as this one: They asked me to ride in a train that would, as best I would be able to tell, travel at no less than 60% of the speed of light. They assured me that no impossible physics was involved but rather a leveraging of ordinary velocities to gather observations at unobtainable speeds. They asked me to come because they had encountered a mystery. I asked, but they would not say. Instead, they only said come; we'll show it to you in person. Perplexingly, they said I was the only one who could help them.

Thus I journeyed by a most ordinary train to visit this most extraordinary of trains. The journey through the pasturelands of the Midwest United States was uneventful and peaceful — a sharp contrast to my worries and expectations for what I anticipated to be a far more eventful and far less peaceful trip. As my mind often does, it went to the beauty and wonder of everyday mundane physics in the trip itself — the momentum in the turns, the accelerations at the various stops, and the subtle but delightful Doppler-effect rise and fall in pitch of the various bells and whistles we passed along. I pondered how my motion impacts ever so slightly even light, the waves that quantize not only on emission but upon receipt. It always amuses me to explain, when the topic comes up, that my one Nobel Prize was not for Special or General relativity but for quantizing light itself.

Upon my arrival, and after completing the always-necessary many rounds of introductions — it is not always very convenient to be Albert Einstein — I was escorted to a vast tunnel containing this most special of all trains. What struck me most was how extraordinarily mundane this train seemed. It was like the one I had only recently departed, with familiar seats and windows. There were, however, three critical additions: An instrumented telescope pointing forward, another pointing backward, and a clear tube running the length of the train. They had also instrumented the tube to observe anything passing through it at any speed.

After a round of explanations of the capabilities of these high-speed and precise instruments, we began our journey. For me, it was with no small amount of trepidation, as my equations made me vividly aware of just how energetic and dangerous an actual trip approaching light speed would be. But again, I was reassured that regular physics applied, that our actual velocities would be mundane and no more dangerous than in an ordinary train. It was only within the train that the amplification of that velocity by many orders of magnitude would render to all passengers the vivid and accurate appearance of traveling near lightspeed.

And, indeed, the impossible crushing acceleration that I so vividly anticipated, despite assurances, never happened. In terms of the pressures my body underwent, it was no worse than any train station acceleration. Visually, however, the world around the train transformed utterly. The transmission and receipt of photons morphed into forms I had long wondered about but never witnessed. Light from in front visibly shifted towards the blue — though, thankfully, not so far as to be fatal. They had already informed me that 60% of lightspeed was as close as they dared to come without requiring protection from light itself as it grows dangerously high in frequency. Towards the back of the train, light from outside shifted towards the red. This shift briefly reminded me of the bells and sirens I had passed only a few hours earlier, except now in light rather than sound.

And I witnessed firsthand the contraction of the outside world, the one that Lorentz had so long ago predicted! The outside world collapsed on itself in the direction of travel, causing the rails we traveled to shrink in length by 20%. There was much visual distortion, but the instruments kept that at bay by focusing only on the points where rails and objects moving through the tubes contacted our world directly. The objects passing through the tubes were clocks — and, in addition to being 20% shorter in the direction of travel, each one-second motion of the clocks took 25% longer by my watch. Time dilation, just as I had predicted, and which I now could witness firsthand!

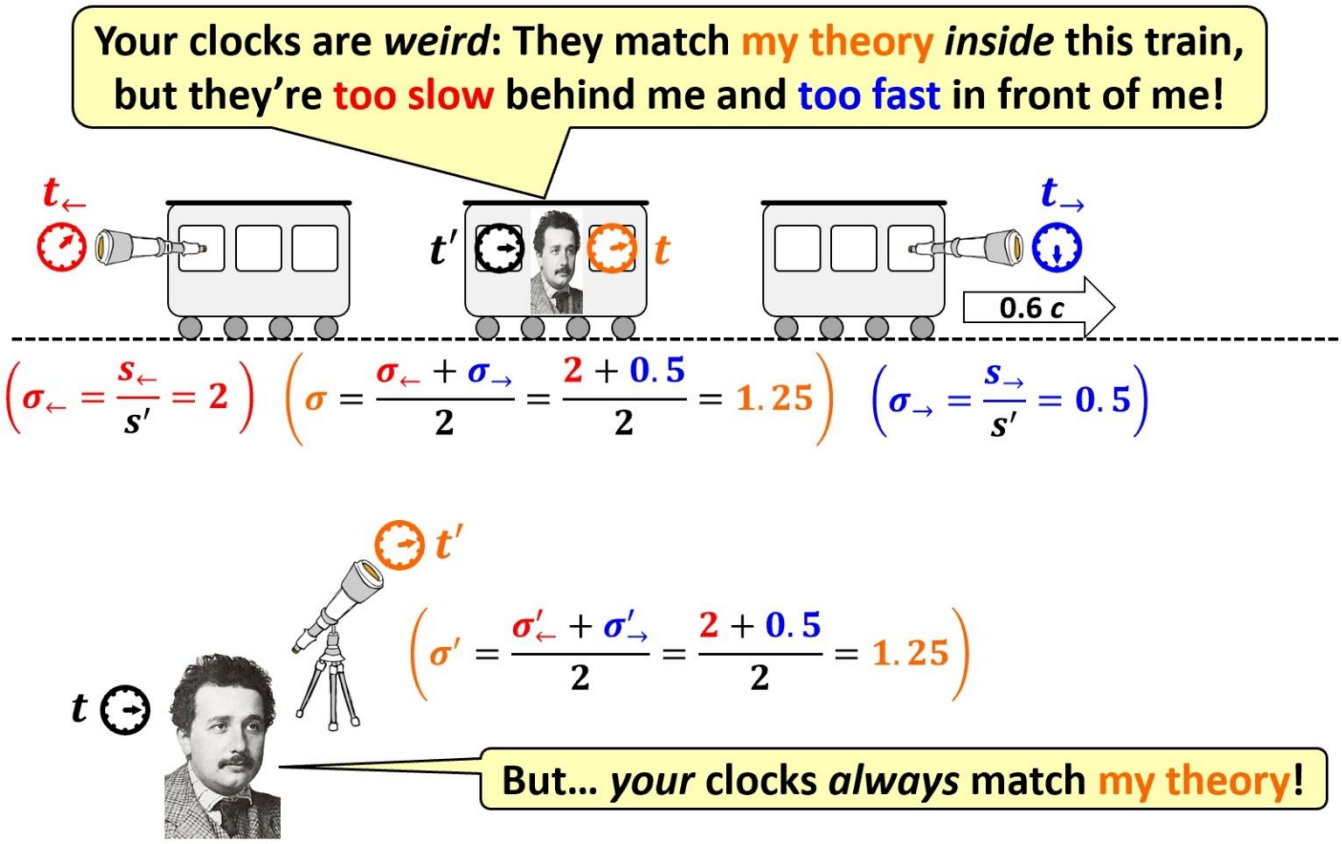
What fascinated me most was knowing that if another copy of myself was outside watching me pass, that alternative Albert Einstein would see precisely the same effects for my train and everything in it: 20% shorter, with clocks ticking 25% slower. It was the beautiful symmetry of space and time first elaborated by Poincaré.

While immensely satisfied by what I had just seen, I was also puzzled. If all results were as I had predicted, why all the mystery? The boost of our train had placed us in a new frame with its own Minkowski coordinate system, and all seemed well. It also confirmed my suspicion that we must exist in a block universe — a universe in which all events must, in some fashion, be predetermined to reconcile the paradox of how two sides can see the other as moving slower in time without creating contradictions.

My host smiled — a bit sadly, I thought — and pointed to the two instruments I had not yet examined: The telescopes pointing forward and backward. Through these telescopes, I would watch the very same clocks passing through the train, both before they arrived and after they departed. Each clock had faces on both sides, so I could use the forward and backward telescopes to watch their slowed time as they came and went.

Except that was *not* what I saw.

The faces of the approaching clocks ran *twice as fast* as my watch, with each of their seconds lasting only half as long as one of my seconds. The faces of the receding clocks ran *twice as slow* as my watch, their seconds lagging to take up two of my seconds. *Neither of these rates matched the Lorentz factor*… yet these were the *same* clocks that matched the Lorentz factor *exactly* as they passed through the tube of our train.



Turning, I looked at my host. My face must have reflected my concern. He nodded and said, "Now you see why we asked you, and no one else, to come. We see the clocks, but we don't understand: How can the *same* clock run time in three different ways, only one of which matches your special theory of relativity?"

I sat down heavily, not just perplexed but stunned. The mystery was as stark to me as it was to my host: How can *one* object present three different cycle times? Why the factor of two, which is not at all like Lorentz's factor? How can one object present *three* different…

Frequencies! As I rode on a mundane train to this meeting… the rise, the transition, and the fall in the pitch of bells! *The Doppler effect!*

The clock faces are *frequencies*… and *so is the light itself*. If the light outside the train were circularly polarized, *it would behave like a clock*. Conversely, the clocks, intimately linked by physics to those same light emissions, must *also* double their rotation speed.

Suddenly, I realized the source of the mysterious factor of 2: The relativistic Doppler equation! For 60% of lightspeed, the relativistic Doppler factor is $R = \sqrt{(1+\beta) \,/\, (1-\beta)}$, giving, in this case, $R = 2$ in the forward case and $1/R = ½$ for the backward case. We just happened to be traveling at the only speed that gives precisely 2!

Time is *not* Lorentzian. It's *Dopplerian*, passing faster in the never-accelerated outside world until, upon arrival, the traveler and the universe come back in synch at the same observed value. A traveler's age gradient! The value… yes, $\alpha_+ = \beta\gamma/c$ in the direction of travel, $\alpha = -\beta\gamma/c$ for the more general case of Einstein outside. Anyone who sees a Doppler change in light before them is traveling into the future of that outside world!

But why is time Lorentzian as the clocks pass through the train? Why do clocks and seconds follow Lorentzian rules during the flip between faster and slower times?

I again thought back to my train trip out, this time when I went to the front of the car to get food and returned. To an outsider, my trip to and from the vendor had *two* parts, one forward and one backward, one Dopplerian, and one inverse Dopplerian… an average! The Lorentz factor applied *inside* the train because every clock *inside* the tube completed its tick-forward and tock-backward before leaving.

If that is true, then… the Lorentz factor should be the *average* of two Dopplerian times, one forward and one backward… yes! It's not immediately obvious, as a bit of algebra is involved. Still, the Lorentz factor for finding the length of a moving clock second is the *average* of its two component times: one forward-moving Doppler time and one backward-moving Doppler time. The slower begins to dominate near light speed, where… yes… the Lorentz time more closely approaches Doppler time.

And… oh… the block universe… unravels. With Dopplerian time there can be no *universal* Poincaré symmetries after all. Those beautiful symmetries still apply, but *only* with my accelerated train's tiny tubes and corridors. Without any meaning to the universe-spanning versions of those symmetries, the boosted spacetimes… my train becomes local, a drifting mote with nothing more than a small, *private* definition of space and time.

My host has been watching my face. I realize now that I've taken him on a rollercoaster of expectations, from my smiles of insight to the final shock of losing the block universe. Perhaps I had not realized how dear it had become to me. The trip had worked, however. We stopped the train and returned to a nondescript conference room. I had an answer to their mystery and summed it up in my earlier figure.

My hosts thanked me profusely for solving their mystery — a mystery that, I gathered from subtle hints, had a significant bearing on the intent and purpose of their remarkable not-really-light-speed train that mimicked actual velocity so well. I never heard more from

them about that purpose, nor did I expect to. They had briefed me thoroughly about the secrecy I needed to take that ride.

Returning home, I face my final quandary: What, now, do I do with my realization that time is Dopplerian, not Lorentzian, at all cosmic scales? How do I go forward knowing that any mention of the Poincaré symmetries now applies *only* to the material participants of an overly idealized boosted frame?

My hosts permitted me to write this note, but with the constraint that it can only be released long after my passing, and even then, only unofficially. As it turned out, this was a constraint with which I was more than happy to abide. One impact was that it has, I think, changed my focus on future work. I wish now to explore more of the worlds of particle physics and quantum mechanics.

To you reading this, my apologies for not being bolder in undermining my block universe. I think you will, nonetheless, find this new Dopplerian time universe interesting indeed.