Angular Lorentz Factors and Time Contraction

Terry Bollinger
2023-02-11.00:12 EST Sat [Summary expanded 2023-02-12]
Message Excerpt

Summary: The standard Lorentz factor is a particular case of the transverse (equatorial) plane of a broader angular function $\gamma_\theta(v)$. For launched observers moving in the z^+ direction relative to the unchanged launch frame, typically earth or the universe, θ is the polar angle from the direction of motion z^+. The generalized Lorentz factor describing how the moving system observes time flow in the unchanged outside universe is:

$$\gamma_\theta(R) = \cos^2(½\theta)\,(1/R) + \sin^2(½\theta)\,(R) \qquad \text{where} \qquad R = \sqrt{\frac{c+v}{c-v}} = \sqrt{\frac{1+\beta}{1-\beta}}$$

The standard Lorentz factor pops out at $\theta = 90°$, that is, for the equatorial $x'y'$ plane of the moving system. This plane is the sideways view from the moving observer's perspective:

$$\gamma = \gamma_{\pi/2} = \gamma_{90°} = \cos^2 45°\,(1/R) + \sin^2 45°\,(R) = ½(1/R) + ½(R)$$

However, even on the equatorial plane $x'y'$, the predictive value of the standard Lorentz factor is reduced by the presence of a traveler's age gradient $\alpha_+ = \beta\gamma/c$ since this is an energized (launched) system traveling through a larger-volume frame. Consequently, the only events to which standard transverse γ time dilation applies are ones whose entire history occurs within the moving system, such as a muon created at the front of the ship whose decay from that point backward in the ship is time dilated by γ. However, due to the traveler's age gradient, the next muon creation event at the front of the ship could take place far in the future as measured by time in the outside world. The predictive relevance of standard γ thus shrinks to very brief events occurring entirely in-ship.

In contrast, the most predictively relevant angular Lorentz factor for a moving ship is always the forward factor $\gamma_{0°} = 1/R$. This factor represents an observed time *contraction*, not dilation, of the outside world. When combined with any age gradients created by asymmetric launches, the ability of angular Lorentz factors to predict both time dilation and time contraction is critical to making accurate state predictions in special relativity.

In the case of a launched system, these factors combine into a simple and universal rule for predicting outcomes: Only $\gamma_{0°} = 1/R$ or, equivalently, the photon imagery "playback speed" factor $\sigma_{0°} = 1/\gamma_{0°} = R$, correctly predicts the time differences seen when the launched system impacts the target. Thus $\gamma_{0°} = 1/\sigma_{0°} = 1/R = \sqrt{(c-v)\,/\,(c+v)}$ is the most important and most easily applied Lorentz factor for launched (energized) systems.

The other conspicuously simple angular Lorentz factor is $\gamma_\pi = \gamma_{180°} = R = \sqrt{(c+v)\,/\,(c-v)}$ or playback speed $\sigma_\pi = 1/R = \sqrt{(c-v)\,/\,(c+v)}$, the slowdown of time in the outside frame when the moving observer looks directly backward. This slowdown represents the difficulty of light overtaking a fast-moving traveler and an increasing spacetime distance.

Terry Bollinger
12:12 AM [2023-02-11.00:12 Sat]

Hi Parth,

Nice to hear from you, and I hope the New Year is treating you well!

>… " I think I might be missing something. How would we reduce the use of Lorentz factors down to an angle that is a function of R and $1/R$? Is it a rapidity kind of angle, or an angle in real spacetime?"

It is a real spherical coordinate angle θ in moving-frame xyz space, where z^+ is the forward direction of motion. Objects at $\theta = 90°$ should, with careful and potentially odd qualifications, show Lorentz factor time dilation.

However, since γ is a dilation factor — meaning it is a time-unit multiplier and thus the reciprocal of a playback factor — the first step is to invert the R factors. The forward view becomes a time-dilation factor of $1/R$ (a speedup), and the backward view becomes a time-dilation factor of R (a slowdown).

Once the flip to all-dilation is in place, my best guess for the math model — and it's nothing more than that — is that the math has the same structure as the probability function for a half-spin fermion polarized spin-up at viewing angle θ, then analyzed using an up-down polarization detector oriented along the travel vector ($\theta = 0$).

When viewing $\theta = 0$ (forward), the detector returns 100% spin-up detection, corresponding to a time dilation of $1/R$. When viewing $\theta = 180°$ (backward), the detector returns 100% spin-down detection, corresponding to a time dilation of R. Finally, for the transverse case of $\theta = 90°$ (moving frame transverse or xy plane), the detector returns a $50/50$ mix of up (R) and down ($1/R$), corresponding to an average of $1/R$ and R.

So… that translates to:

$$\gamma_\theta = \cos^2(½\theta)\,(1/R) + \sin^2(½\theta)\,(R)$$

The caps-substitutions version for Google Equations testing, with T for θ and R for R, is:

((cos(0.5(T))^2)(1/(R)) + ((sin(0.5(T))^2)(R)

Testing… yes, I'll be darned; the silly thing replicates the desired profile correctly. That is, it at least gives $1/R$ for $\theta = 0$, $\gamma = (1/R + \mathrm{R})/2$ for $\theta = (\pi/2)$, R for $\theta = \pi$, and is smooth in a plausible (quantum!) way between fenceposts.

(And if you are thinking, "Um… It doesn't look like Terry is big on rigorous mathematical proofs and derivations as his first step in deriving new equations…" GUILTY‼)

What's weird is that I can't get the idea out of my head that it's not a coincidence that applying quantum math, particularly fermion half-spin math, to R factors and the Lorentz factor gives a continuum between them. In some odd and interesting way I'd like to explore more, I suspect that the Lorentz factor is also, in the proper quantum-scale context, also part of the worst-case scenario about the least knowledge of the state. This possible connection gets back to that whole acceleration-as-observation bit.

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Another issue: I still don't understand why the playback speed for external events is R (or $1/R$ dilation) forward and $1/R$ (or R dilation) backward. Seriously, would you happen to have any ideas on that point? Why is this number even showing up in the forward and backward cases?

I do know that the only playback factor that counts, in the end, is the forward (target) time compression R because that's the only direction that *reduced* the Lorentz area distance between A and B. Anytime a Lorentz area increases, such as in the backward (launch) direction, space-vs-time trade-offs increases. That trade-off increase between space and time is why special relativity works nicely without block universes.

In contrast, forward motion towards the Lorentz area shrinks that area smoothly until it becomes small enough to approximate a point-like causal event in spacetime, leaving a trail of continually shrinking future options as the area shrinks. Is there a differential math for areas? With causality included as a multi-scale process? It doesn't ring any bells from my old Diffy Q classes. None of that is surprising in the *xyz* approximation since it just means that the farther the ball, plane, or spaceship travels, the more the future of where it lands becomes irreversible. The trouble is that most such equations don't capture the spacetime interchangeability issue in such dynamics.

That's more than a lack of relativistic invariance since most SR equations do not capture that multi-scale variability, to my knowledge. I don't think they can do that if they don't explicitly capture the $L_x L_y L_z$ distances.

Two dimensional causal Diffy Q? Heh! Yet I'm pretty sure that's what's needed.

In any case, forward-looking, convergent $\sigma_0 = R$ ($\gamma_0 = 1/R$) and backward-looking, $\sigma = 1/R$ ($\gamma_\pi = R$) are *never* symmetric in terms of causality. Quite the opposite: convergent motion shrinks the spacetime interpretations and thus moves towards specificity and causality, while divergent motion expands the spacetime interpretations and thus moves away from specificity and causality. Phrased more colloquially: Things happen after you leave home, and you cannot do much about it.

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Finally, I've little doubt that the forward-backward speedups are related somehow to asymmetric time velocities and, thus, asynchronous equivalence. Reality only becomes real when all these silly loops get completed. Until they do, the seemingly "undetectable" asymmetries of special relativity — the ones that require enabling asynchronous systems to display identical physics to synchronous ones — probably are much more real than we think and (somehow) provide a more intuitive way of understanding, say, twin paradoxes.

Cheers,
Terry

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PDF: https://sarxiv.org/apa.2023-02-11.0012.pdf