# Why Planck Foam Breaks Lorentz Invariance (The Glass Analogy)

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Part 1: https://youtu.be/szI-HpOScFQ&lc=Ugx5uraBbWqwyCB62K14AaABAg; Part 2:
https://youtu.be/szI-HpOScFQ&lc=UgzI4GqplGcKmJP0TjV4AaABAg.9u0pd6kMwnR9u3Qut31TEB

A Comment on the SciShow (YouTube) post:
*The Weight of "Nothing" Could Mean Everything (to Physics)* (Aug 29, 2023)
https://youtu.be/szI-HpOScFQ

@drdca8263 asks: *"Would a quantum spacetime foam imply a violation of Lorentz invariance?"* Yes. Any experimental observation of a frame-detached spacetime foam would spectacularly violate Lorentz invariance by proving the vacuum is, after all, nothing more than an 1800s-ish aether. It would prove spacetime is nothing more than an unbelievably dense fluid whose smallest particles, such as [super] strings or looped versions of gravity, transmit a broad range of vibrations corresponding to the particles of the Standard Model.

However, blaming Wheeler's foam for the Lorentz invariance violation is disingenuous.

The hidden-in-plain-sight secret is that *all* quantum field theories are single-frame aether theories that use a superdense fluid of vibrating particles to *mimic* the gorgeous space-and-time symmetries of Poincaré, Lorenz, and Einstein. From Wheeler's perspective, the Planck scale was not the beginning of Lorentz invariance violation but the point at which the quantum field theory emulation of such behaviors must fail due to rampant quantum uncertainty converting their complicated particles into mush.

Thus, the more precise answer to your question, @drdca8263, is this:

Unequivocal observation of a frame-detached quantum spacetime foam would prove that the 1800s-ish aether hypothesis that underlies all variants of quantum field theory is *correct,* and that the 1905 special relativity Einstein was wrong. The foam is the energy level at which this aether *fails,* and with it, the illusion of symmetries that fooled Poincaré, Lorentz, and Einstein into thinking that spacetime physics is wholly independent of inertial frames.

One final point: Did you notice how I kept saying "frame-detached" quantum foam?

Folks often quote the Casimir effect as proof that small distances hide almost infinitely intense electromagnetic waves. Yet it is, ironically, a profoundly weak effect that never accomplishes anything more exciting than quietly but firmly cold-welding bits of metal that get too close in a vacuum. Why is that? If you want to dig into the maths, Jaffe 2005 is an excellent example of why there's no real need to get all zero-pointy in such analyses. Atom are atoms, metals are metals, and neither ever act as infinitely sharp boundaries to anything. Casimir knew this in his beautifully done 1948 paper and added the corrections needed for his beautifully accurate prediction.

The subtler point is this: Even quantum vacuums never produce wave effects whose energies and frequencies *exceed* those of the objects and instruments involved in the experiment. It has to be that way since that's the burry limit quantum mechanics enforces in all such situations. The direct implication is that the available matter and energy, not the emptiness and nothingness, always drives experimentally observable effects.

Seriously: Is the idea that what's observable is, in the end, always determined only by the fields and energies associated with actual matter all *that* surprising? After all, even in black holes, the total curvature depends on the mass and energy added.

Finally, if you are still interested, you may now want to look at my comment from yesterday, which is Part 2 of this comment. In Part 2, I address the Planck Foam Reveal of sneaky-invisible quantum field theory aether-glass more lightheartedly.

Is this switching of order an instance of Reverse Causality? Time Travel? Temporal Casimir Pressure? Hossenfelder Quantum Unerasure? :)

Nope. I accidentally edited out my first word, "yes," when answering @drdca8263 yesterday, so I was genuinely puzzled and troubled when he asked why I never directly answered his question. Ah… oops! Thus, the Part 1 you just read was the expansion of my original brief "yes" from yesterday, with, by way of apology, some added discussion, and (hopefully) clarification of some points.

Please now go to Part 2 on Aug 30, 2023! Future to the Back!

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Part 2 (from Aug 30 2023)

Imagine someone giving you a sheet of the most perfect glass in the universe, one that is not only perfectly transparent index but has the same index of refraction as the vacuum or (roughly) air. You can hold the sheet and toss it in the air, but you'd better toss it carefully since you won't see it again until it hits something. (Fortunately, it's also very tough and doesn't break easily.)

A spaceship zips by at 99.5% of the speed of light just as you toss the glass in the air. Madison, the pilot, looks for your sheet but sees nothing. She cannot tell your sheet of glass from one she holds in front of her on the ship since both give *no* indication of where they are. Madison finds this inability to identify who owns which sheet of glass fascinating and calls it Lorentz invariance after the brilliant condensed matter physicist Loretta Lorentz, who invented the glass. Lorentz invariance, in a nutshell, says that *no one* can tell who owns any of these pieces of glass, no matter how they are moving.

Curmudgeon and experimentalist that you are, you decide on a new test: You pull out your handy Planck Blowtorch and heat your sheet of glass until it glows, then toss it in the air again.

Madison phones you and says, "HHHHHHHHH…" Sorry, I forgot to correct the tenfold time dilation: "Hank! I can see your sheet now! How did you break Lorentz invariance for your piece of glass?"

You say, “Madison, it was easy! I merely heated it with my Planck Blowtorch until it glowed brightly! The heat also blistered the surface, making the glass even more visible. I’m calling the combination glowing radiation and local texture Planck Foam, and wow… it does a great job of breaking Lorentz invariance!”

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Special relativity’s most profound and essential lesson is not what folks think. We tend to focus on how odd it is that a ship can shrink and its clocks slow without those on the ship seeing any difference, but the most remarkable principle is that the *medium* in which ships and clocks move cannot give any clues about what is going on. If the medium reveals itself, every moving observer need only look at it to determine their state of motion.

As with Hank’s manipulation of the piece of glass, you can add energy to this otherwise invisible medium to make it do tricks. Thus, by using the blowtorch of electric field energy inside an atom, you can make this invisible medium cough up, ever so briefly, pairs of negative and positive electrons that blur the charge of the atomic nucleus. Near the surface of a small but intense gravitational body, you can *curve* this invisible medium enough for strain energy to produce the asymmetric particle pairs called Hawking radiation. The shared feature of these two cases is the addition of energy from some well-defined collection of mass and energy — that is, from a *known* inertial entity. Without that known entity and its well-defined inertial frame, nothing happens.

The trickiest and most interesting case for this invisible medium is this: How does a photon — a quantized pulse of electromagnetic energy — manage to travel across the universe *without* some aether-like medium in which to travel? That is why the aether was first proposed in the 1800s: as a medium through which light and other wavelike radiation can travel.

Quantum field theory attempts to solve this problem not by adhering strictly to Einstein’s disturbing revelation but by creating an aether so incredibly fine-grained — perhaps infinitely fine-grained — that *every* wave, regardless of frequency or intensity, passes through it with identical ease. It only takes a few mathematical tricks of tilting the angles of space and time to make such an aether give the same results that Einstein predicted, so why bother with *really* giving up the nicely math-friendly classical aether? In often carefully phrased language, many expected that in time and with high enough energies, Einstein’s more radical aether-free version of special relativity would fail.

It did not. That Einstein was a clever fellow.

By definition, the answer to Einstein’s still-lingering mystery of how to construct a genuinely aether-free universe cannot be some almost infinitely deep network of clunky resonators — strings, loops, Planck foam vibrations, whatever. Instead, it necessarily resides in some deeper unraveling of what words like “space” and “time” even mean.