Special Relativity as a Non-Relative Localized Gauge Theory

Terry Bollinger
2023-12-21.10:59 EST Thu
https://youtu.be/P6GrtCb6MnQ&lc=UgyrohKdOYC2UaFfnY54AaABAg

A Comment on the Parth G (YouTube) post:
The Guy Made Most Physics Theories Redundant (Dec 19, 2023)
https://youtu.be/P6GrtCb6MnQ

Terry Bollinger on 2023-12-21.10:59 EST Thu:

Parth, thank you for a great and easily understood explanation!

Your addition of 3 to all of the numbers reminded me of a gauge invariance analogy I've used a couple of times: When you are paddling a boat at the surface of a lake it doesn't matter whether the lake is 10 meters deep or 1000 meters deep — that is, your boat paddling is "gauge invariant" for the depth of the lake. As long as your wave activity remains confined to near the surface the depth of the lake doesn't matter.

Yet that depth is real in terms of the energy it contains, e.g., if the lake is drained to a lower level. Such a deep lake storing lots of energy corresponds to a high electric field and energizes an entire region of space in which smaller-scale electromagnetic activity is occurring.

Parth G on ~2023-12-22 Fri:

Hey Terry! This is a really nice analogy that I think I might have to steal (with credit of course) in the future :)

Terry Bollinger on 2023-12-22.15:00 EST Fri

Parth G, thank you, and you are most welcome. But seriously, I think it was more your analogy when you added an equal electrical potential to all points across the surface. All I did was translate that description into the classic water-level analogy of electric potential. :)

Terry Bollinger on 2023-12-23.11:06 EST Sat

Parth G, also, thanks for bringing this one up. As with your Dirac delta function video a few years back, this video made me question my analogy more carefully. The question is this: Is it *really* correct to say that lake depth is like a mathematical gauge invariance since it's always only approximate? Obviously, if the paddle is big enough and moved quickly enough, the analogy can break down in shallow water due to interactions of the paddle waves with the ocean bottom.

But that's also where it gets interesting regarding the *physics* meaning of gauge invariance, which should always be distinguished from the overly simplified assumptions of formula-only gauge invariance. Take electric potential: You can raise it arbitrarily high within a hollow metal sphere, and as with motion in special relativity, there are no internal tests you can do to prove that the potential is there. That is truly amazing and one of the deep features of physics, one just as profound as special relativity, even if less widely known.

But here's the catch: *You cannot make such a sphere infinitely large,* and thus can never create an electrostatic gauge invariance that is any more "perfect" than the lake example. For example, suppose someone inside a large, charged sphere creates a sufficiently powerful electromagnetic wave. In that case, that wave will impact the sphere surface just as reliably as a large enough paddle wave can impact the bottom of the lake. Significantly, it also takes more and more energy to create the region inside the sphere as the sphere gets larger. This is comparable to the need to use energy to accelerate an object to high velocity. The physics *within* the object is absolutely invariant, but its acceleration history is *not* relativistic because it involves a historically irreversible transfer of energy.

So again, thanks. As usual, you inspire me to look more closely and critically at my assumptions. This insight on the need for energy-aware, finite-scope gauge maths to replace overly simplified assumptions about how reality works is closely akin to what I'm working on now for special relativity, which has fascinatingly similar problems.

(More bluntly: *Every* mention of $x'y'z't'$ in Einstein's 1905 papers is mathematically incorrect because it assumes infinitely fast, infinitely low-energy-cost creation of a meaningful coordinates system that, in reality, usually never comes into existence. Therein lies the real resolution of the twins’ paradox.)