

Why Quantum Field Theory is the Theory of Inertial Frames

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2022-10-22.00:05 EDT Sat

(Addendum on quantum collapse as QFT-packet mergers added 2022-10-23.23:20 Sun)

<https://www.youtube.com/watch?v=eoStndCzFhg&lc=Ugzn3f2XTuWf2l5H5Zl4AaABAg>

A Comment on the YouTube Arvin Ash post:

From Particles to Fields: The Most Beautiful Theory in Physics!

<https://youtu.be/eoStndCzFhg?t=7m8s>

[7:08](#) "There is a field for every particle in the Standard Model." Uniquely, our species combines physical and social cognition. Like many complex living organisms, we quickly comprehend a wide range of complex but common dynamics in the physical world, with waves arguably one example. Our distinction is how we convey and elaborate those insights over space and time, with the power of mathematics arguably the pinnacle of this socialization of high-precision physical insights.

There are also dangers within this unique cognitive pairing. If we can share an idea precisely, we can also convince ourselves that an insight shared is an insight *understood*.

The powerful concept of "a field for every particle" is science's supreme paradox, providing its best and worst predictions. Its particle predictions are robust and precise over an astonishing number of digits, yet as usually interpreted, it is also the direct source of the utter insanity of the vacuum density catastrophe. However, even within its range of solid and beautifully precise predictions, it dances too quickly, as if inconsequential, over an obvious question: Out of a literal infinity of mathematically conceivable fields and field properties, why is this astronomically tiny subset of conceivable fields the only one we observe?

When the chemical elements first emerged as distinct and well-defined entities, I suspect at least a few people argued that the elements were simply givens to be accepted as such. Fortunately for modern quantum chemistry, this minority view never made much headway. Alas, for quantum field theory it prevailed.

A primary duty of science is never to accept the existence of small sets of obviously similar items as "givens." The similarity alone argues powerfully that some deeper structure hides beneath them. That is one of several critical insights still missing from quantum field theory.

Speaking of missing, why *is* gravity missing? One might also ask why gravity is the only force that does not induce inertial forces — the feeling of acceleration — when it pulls two objects closer. Another name for this peculiar deviation is Einstein's equivalence principle, the idea that gravity and the force of acceleration are in some way different aspects of a single underlying reality. The equivalence principle is the foundation of General Relativity and a feature *never* found in boson-mediated forces. That alone suggests that despite their superficial similarity of causing objects to move toward each other, gravity and the three forces of the Standard Model are *not* closely related.

Another oddly glossed-over feature of quantum field theories is that all variants of this mathematical framework are inherently frame-locked “ether” theories. Why would I say that? It’s not complicated. No matter how many new inertial frames a quantum field theory invokes *within* its diagrams and calculations, its application to any testable system starts and ends with potentials with locations well-defined relative to each other.

Those starting points with well-defined relative locations in spacetime form a well-defined inertial frame, meaning that all of the new inertial frame states proposed within those figures and equations are necessarily energy-limited children of that finite-energy starting frame. In retrospect, this odd bit of skipping over such a critical detail began over a century ago and has had more than a bit of help from the space-prioritizing neural designs of our brains. Pre-Einstein Faraday assigned every point of his singular-inertial-frame “space” with sufficient real-vector data storage capacity to give every infinitesimal point in a 3-space the capability of retaining indefinitely the infinitely precise real-vector data needed to express multiple field vectors over an astonishing range of magnitudes. Forget physics for a moment: Any modern technologist would recognize this not as a vacuum but as an impossibly energy-intensive, near-infinite matrix storage device equipped with sufficient mass to preserve each bit for indefinite durations of time. Faraday’s initial misconception of how space works, rather than any twiddling with the parameters of relativity or quantum field theory, is the true origin of the vacuum density problem.

Quantum field theory’s models are robust and beautifully predictive, and this will never change. They are, in fact, the correct mathematical description of how any given collection of mutually communicating matter and energy forms a well-defined inertial frame. The catch is that this modeling power comes into play only when supplied with energy, mass, potentials, and a well-specified inertial frame. Notably, such ether theories have no connection with the featureless, energy-free, multi-frame vacuum of special relativity.

Since inertial frames are the units for exchanging momentum across diverse scales, quantum field theory has been underutilized as a model for understanding and quantifying the many odd relational complexities of matter and energy within and between internally bound classical systems. For example, the system-wide inertial-frame unity of QED allows a massive and profoundly classical mirror to gain a tiny impulse of momentum from a photon that reflects from it, despite no one electron ever absorbing that photon. It is also worth noting that for those who hope to find some more profound unity in the fabric of quantum field theory physics, the existence of hierarchies of quantum fields at vastly different scales of space and time does provide hope. Ironically, we can never understand when and how that unity applies until we do a better mathematical job of capturing the *limits* of quantum field theory.

Finally, we need greater awareness of how our biological biases can subtly undermine our understanding of a universe that works more in Poincare symmetries and light cones and doesn’t always feel a burning need to match our *xyzt* expectations.

Addendum 2022-10-23: *Wave Collapse as QFT Frame-Packet Mergers*

For completeness, I should mention that quantum wave collapse is real but better described as a bottom-up merger of previously isolated QFT frames. The cause is always the same: A two-way exchange of minute, unquantized quantities of linear momentum.

When one QFT “frame packet” is immensely larger — e.g., an experimenter — than another QFT packet — say a free hydrogen atom in space — the acceleration of the larger frame is almost, but not entirely, undetectable, as proven by the existence of solar sails that steal trivial bits of momentum from many photons to accelerate space probes. The larger object undergoes almost no changes in its QFT organization, except that it receives enough momentum to gain something called “information” about the smaller frame. That’s all information ever is. It is exchanges of momentum (or, in the more interesting case, mass) that identify (“observe”) the relative location of two QFT frames and, at the same time, merge them into a single new QFT packet with a new inertial frame.

When the QFT packets are comparable and small in size, such as two particles colliding, the newly merged QFT packet can remain sufficiently isolated to stay quantum from the perspective of outside observers. These QFT merger cases form a continuum in which higher masses and more complex systems “know” more precisely where they are relative to the rest of what we think of as the universe.

Wave-collapsing momentum transfers are a testable idea. When photon wave functions “see” branches of an apparatus in which the photon never deposits quantized *energy*, that does not keep the wave function from imparting an incredibly tiny bit of momentum into other “blind” parts of the apparatus, just as those photons did on solar sails. Such tiny momentum deposits should, in principle, always be detectable with the proper setups.

The hidden momentum part is not new. My first mention of the necessity of cryptic momentum transfers was over two years ago:

First Prediction of Momentum-Pair Creation in Stern-Gerlach (July 28, 2020)

<https://sarxiv.org/apa.2020-07-28.1338.pdf>

If I sound too confident about this topic, it’s those solar sails. They are inexplicable under QED, which confines momentum transfer to the particle level. Recognizing that QFT is the binding unit for these classical-object-level momentum transfers — and this is new — should, in time, make the model nicely mathematically specific and predictive.

Despite the remarkable successes QFT has already chalked up, its journey in making new predictions about how the universe works is far from over. Far from undermining its power, a “granular QFT” interpretation — one in which QFT breaks down into multiple scales of isolated, mass-and-energy ether units — converts it from the cause of the vacuum density catastrophe into the foundation unit for the emergence of cosmic spacetime. A deeper understanding of how multi-scale QFT packages interact with each other should, in the not-too-distant future, at last, explain gravity at a deeper level. The equivalence principle of General Relativity — the rule that says that smooth gravity does *not* cause QFT mergers — is an essential clue for that part of this upcoming endeavor.

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2022-10-22.00.05 EDT Sat

PDF: <https://sarxiv.org/apa.2022-10-22.0005.pdf>