A Quick Assessment of Constructor Theory

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2022-08-23.15:45 EDT Tue
https://www.youtube.com/watch?v=Jz3mOlUOGoY&lc=UgwQqgta235Z8BELWfB4AaABAg

Comment on YouTube Dialect in the post:
Newton vs. Mach: The Bucket Experiment
https://youtu.be/Jz3mOlUOGoY

Regarding my earlier comment that rotating frames are collective particle excitations, @Littleprinceleon asked, "What about the constructor theory approach?

This question surprised me, but on reflection, there are similarities between what I said and Deutsch and Marletto's idea that the rules and concepts of physics emerge from a deeper substrate. However, their substrate has an unlimited quantum computation capacity from which physics rules emerge via a counterfactual consensus process. My substrate consists of hierarchies of multi-scale cascaded pair productions that eventually gain the ability to persist — we call it time — and form universe pairs with strictly finite, energy-limited information densities.

Deutsch and Marletto assume quantum computation is deeper than physics. This idea is rooted in the assumption that the entire physical universe has an infinitely differentiable (infinitely smooth) universal quantum wave function. The problem is that all observable examples of quantum wave functions have light-cone-limited boundaries whose finite sizes ensure that, at best, they can only approximate infinite mathematical smoothness.

That sounds like a nitpick, but infinite differentiability unavoidably requires infinite information densities (harmonics) to encompass all the sharp curves and bends of just one classical universe, let alone a superposed infinity of such beasts. These mathematical ghosts appear in unguarded calculations to form the substrate from which Deutsch and Marletto build their quantum version of universal constructors. These same infinities are the deeper cause of the vacuum density problem since the unguarded assumption of infinite differentiability exists everywhere in physics math. Physics in the actual universe does very well at staying finite. It's just our models that like to blow up.

Another problem is that Deutsch and Marletto's constructors violate special relativity.

The only way diverse inertial frames can "share" the same empty region of space is if the region has zero causal information capacity. Converting space into a quantum computer that creates the rules of physics makes it a participant with a well-defined inertial frame to avoid paradoxes. Since the 2020 HAWC examination of 100 TeV gamma rays demonstrated Lorentz invariance up to 1800 times the Planck energy, there's no evidence for the kinds of violations constructors would require. (This is also true for superstrings.)

You might think general relativity violates this point, but that confuses empty flat space with energy-containing curved space. Only by adding energy can any region of space become locked into a specific inertial frame.

Finally, I can't resist doing a bit of a one-up on Deutsch and Marletto: Quantum wave functions and quantum computing, far from being fundamental, are _just as emergent_ from some deeper substrate as any other feature of physics.

Why shouldn't they be? Schrödinger wave functions are, after all, superpositions of momentum states, and momentum is very much a feature of matter and energy, not of empty space. While it's beyond the scope of this reply, the fact that momentum states always form in pairs also means that "free" quantum wave functions are, in fact, deeply entangled with the equipment and environment around them — and yes, that's a Zurek superselection reference. If empty space does nothing computationally, the power of any given quantum computer stems not from any capability of empty space but from the detailed form and nature of the classical environment surrounding the wave function.

2022-08-23.15.45 EDT Tue
PDF: https://sarxiv.org/apa.2022-08-23.1545.pdf

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Quantum computing in particular relies on imperfect wave functions that always begin

Quantum computing in particular relies on imperfect wave functions whose form depends on the classical histories imposition of constraints — entanglements or, roughly, Zurek's superselection rules — by _finite_ sets of matter and energy. Folks who do quantum computing might want to pay a bit more attention to that possibility, since if quantum computing derives not from the wave function itself but from all the ordinary matter surrounding it, the levels of noise are going to depend a lot on how much and what kinds of matter defined the wave function.

We could not disagree more on the nature of that deeper infrastructure, however.

However, their substrate is a variant of Everett's unbounded many-worlds concept, and from that it includes effectively infinite quantum computational capacity, since Everett removed all quantization barriers to the growth of harmonics in his universal quantum wave function. Laboratory quantum wave function never do that. From that capacity comes to a sort of "counterfactual consensus" on what to forbid and what to allow, and that consensus becomes physics.

However, they describe their substrate as what amounts to a vacuum with infinite quantum computational capacity

However, their vacuum has unbounded information and quantum computational capacity, which is a natural result of Deutsch's support for Everett's many-worlds interpretation. The many-worlds concept encodes its worlds as harmonics of a universal wave function whose level of detail, and thus information, grows without bounds. Waves observed in laboratory physics never not do this, since they always quantize instead.

Out of this infinite computational capacity they

Einstein got his only Nobel Prize for figuring that out, since it kicked off the field of quantum mechanics and solved the ultraviolet catastrophe problem. Everett, in contrast, chose to accept

. That is a natural outcome of Deutsch's support of the many-worlds interpretation, since Everett proposed a universal wave function capable of infinite detail, with new universes encoded as harmonics of that universal wave. Sean Carrol calls the substance of this wave function "energy," but no version of energy observed in labs

discards wave collapse and instead allows permits equivalent of the ultraviolet catastrophe. Everett interpreted the resulting infinitely detailed, infinitely information-dense wave function as a superposition of infinitely many universes.

that first _led_ to quantum theory. Sean Carroll calls this non-quantized substance "energy," in part because infinitely detailed harmonics and thus information. That's not possible energy as observed in laboratory physics, so for that , and for that reason, such a postulated substance should never be called "energy."

For me that includes spacetime itself, which, if you think about all the equations required to describe it, is a remarkably complex beast with lots of rules and constraints.

Where we part ways, rather dramatically, is in the nature of that simpler infrastructure.

Oddly,

While I respect and admire Deutsch and Marletto for their boldness in talking openly about the superposition continuum math to its logical limit of infinite , but

I'm breaking this long answer into parts. A PDF copy is available via a link at the bottom.

** An Excellent but Missing Video-Intro to Constructor Theory **

Chiara Marletto gave an excellent overview of her constructor theory in a Golden Webinars in Astrophysics presentation on January 28, 2022. David Deutsch, who is the coauthor of constructor theory, was on the panel that day and helped answer questions. I was not on the panel that day, but as usual, I asked a lot of questions. I recall being surprised to find out what the phrase really means, and I asked some pointed questions about the value of a proposed (and potentially very costly) gravitational experiment that was mentioned.

Unfortunately, and as with quite a few other excellent Golden Webinars including Roger Penrose and many other notable figures as speakers and panelists, this particular presentation does not seem to be available online, at least not in the US. The only trace I can find of it now is this Facebook video ad for it by Chiara Marletto:

https://www.facebook.com/watch/?v=362773958564182

If anyone reading this knows of a link to Marletto's full Golden Webinars presentation on constructor theory, perhaps in different region, would you be so kind as let folks know about it? It's a bit sad when someone gives a nice talk on a theory that has gotten a lot of attention, yet the video ends up not being available for new folks to hear it. Marletto and Deutsch did a great job of explaining their ideas, and did so in a nicely compact video.

** Quick Summary of Constructor Theory **

** Positive Aspects of Constructor Theory **

What I like most about constructor theory is that it's intellectually honest. Just as anyone who believes in a block universe is a closet