Deciding on the nature of time and space

Abstract

Special relativity centers on two key aspects: a formal transformation and an ontology, differing from the pre-relativistic ontology. Recent papers [1,2,3] discuss century-old issues associated with the ontological problem. Per Thyssen [1] "*Special relativity leaves the debate about the dimensionality of the world underdetermined*." This underdetermination requires a decision that lies outside the formal rules of the theory.

Several years ago I thought that special relativity was an exceptionally simple theory; after all, it is basically just application of the Lorentz transformation between frames formulated as 4D space-time. However I've recently decided that Rovelli [13] is right:

> *"Special relativity is a subtle and conceptually difficult theory."*

This is not because of any complexity associated with the Lorentz transformation; it is, instead, based on difficulties associated with the ontology of space and time in this framework. I'll spare you a series of quotes by prominent relativity authors, to the effect that relativity is *weird, hard to believe, crazy, non-intuitive, etc.*, but we should not dismiss these remarks; they are true. Intuitively, mankind held a commonsense conception of absolute time and space, where absolute time means universal simultaneity – the same time everywhere in the universe at this moment, right NOW – and absolute space means that a preferred local frame exists. Einstein demolished these ideas in 1905. The following metaphorical overview of relativity ignores historical issues of Maxwell-Hertz, Michelson-Morley, and Lorentz transformation, *all of which are to some degree problematical*, in favor of a simple but accurate picture of Einstein's theory:

> Einstein, observing that a juggler can juggle balls as easily in a uniformly moving railcar as in the railway station, created *cartoon worlds* to model the situation. Obviously, the laws of physics hold in both worlds, else one could not juggle in both. Similarly, spatial coordinates can be mapped onto either world; at rest or moving. However, Einstein provided each world with its own absolute time and space by assigning each world its own universal time dimension, *a radical break with the physics of the time*. He provided absolute space for each by effectively assigning each world its own 'ether', whereby light propagates with speed *c* in each world. And no world is preferred over any other world.

Relativists *always* formulate their problems in such manner that two or more inertial reference frames, *each with its own universal time dimension*, are related by the Lorentz transformation – a geometric transformation in 4D space-time connecting two of Einstein's 4D cartoon worlds. The concept of simultaneity is replaced with 'relativity of simultaneity'. Yet it is a mistake to assume that Einstein presented us with a new ontology of simultaneity. As Rovelli [2] points out, relativity is *not* the discovery of a new ontology of simultaneity; it is the discovery that distant simultaneity is not measurable, hence *not* a provable fact. Einstein merely found this hole in the logic of universal simultaneity and he drove a freight train through it. The net result however is that we are left with *ontological non-facts*.

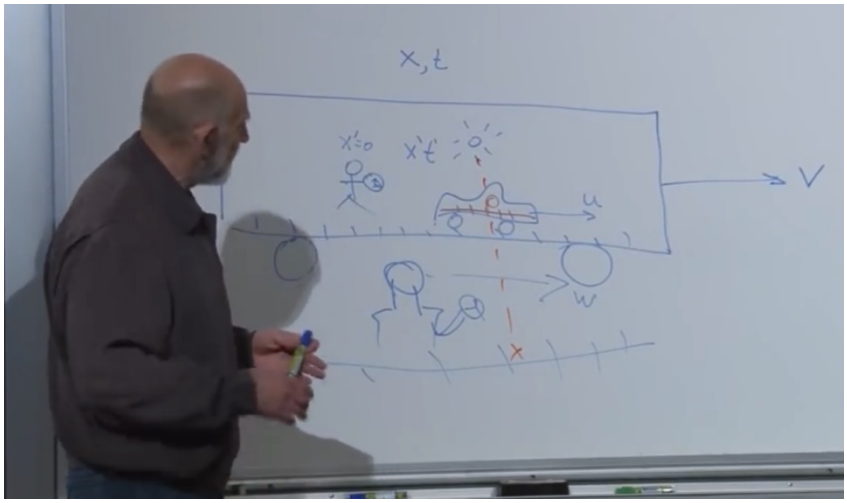
There are many aspects of relativity that make people unhappy, but "the empirical success" of relativity in the twentieth century tends to keep people in line. Of these successes, I believe the

key aspect of relativity that convinces most physicists is *time dilation*, the name associated with the fact that *'clocks in motion run slower than clocks at rest.'* Thus it is significant that one can derive time dilation in a theory of *absolute time and space* [4,17]. This provides an alternative interpretation that has been missing for over a century!

While it is possible to catalog a list of problems with relativity, and I have done so [11], the list turns out to be quite lengthy. Instead of repeating these here I will take a very specific problem that offers new ontological insight.

The problem concerns three bodies in relative motion. In order to compare with standard relativity I choose Professor Susskind's video lectures at Stanford University. [5] He begins with the classical example of the railway car moving at constant velocity with respect to the railway station at rest. As observers in the station, we view the railcar as moving with velocity v in our rest frame S. The frame of the observer in the railcar is S', and the relativity approach transforms S into S' via the Lorentz transformation. Space-time points in S are related to the corresponding points in S' via the Lorentz transformation, and vice versa.

We then add another object moving in the S' frame. The frame associated with this object is labeled S''. In order to be compatible with the Stanford lecture, we will label the object in the frame of the railcar a 'kiddie car', at right.



First we analyze this three-body problem in terms of our theory of absolute space and time. In the spirit of relativity, Susskind assumes that the velocity of the railcar – relative to the station – is $0.9c$. In other words, the railcar is initially at rest in the station, and then is accelerated to 90% of the speed of light. This is conceivable in absolute time and space and imposes only practical problems. If we now wish to impart velocity to the *kiddie car* in frame S', we do so by accelerating the kiddie car. From our perspective in the rail station the kiddie car is obviously limited to velocity $v < 0.1c$. If the kiddie car equals or exceeds $0.1c$ then it will travel at the speed of light with respect to our rest frame and this is verboten.

This is <u>not</u> the physics of relativity. where the act of *placing the kiddie car inside a moving railcar removes us from reality*, as implied by Susskind. In his lecture [5] Susskind shows the kiddie car moving at $0.9c$ *relative to the railcar*, which is itself moving at $0.9c$ in absolute space.

Susskind derives the *velocity addition law* for a 'kiddie car' moving with velocity u inside a railcar moving with velocity v relative to the station. At ~15 minutes he asks what the velocity of the kiddie car, w, is *with respect to the station*, and, based on Lorentz,

$$x' = \frac{x - vt}{\sqrt{1-v^2}} \qquad t' = \frac{t - vx}{\sqrt{1-v^2}} \qquad c \equiv 1$$

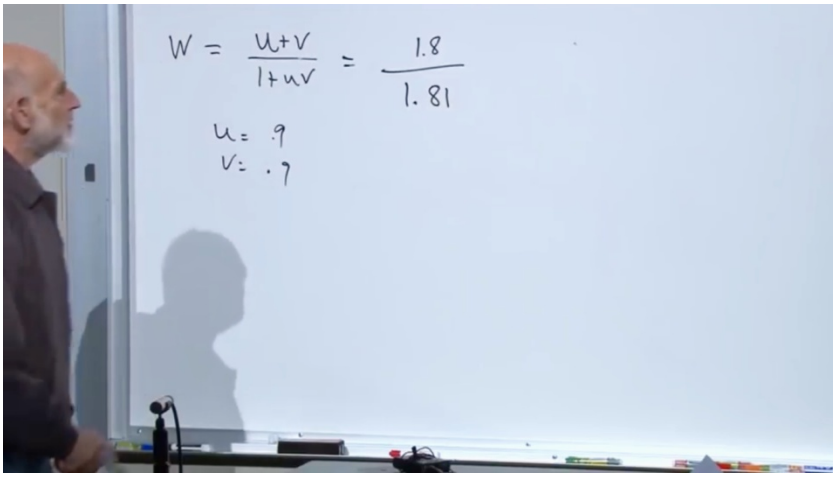
$$x'' = \frac{x' - ut'}{\sqrt{1-u^2}} \qquad t'' = \frac{t' - ux'}{\sqrt{1-u^2}}.$$

Plug x' into x'' in terms of t: $x'' = \dfrac{x - vt}{\sqrt{1-v^2}\sqrt{1-u^2}} - \dfrac{u(t - vx)}{\sqrt{1-v^2}\sqrt{1-u^2}} \Rightarrow \dfrac{(1+uv)x - (v+u)t}{\sqrt{\ }\sqrt{\ }}$

If $x'' = 0$ we obtain: $x'' = 0 \;\Rightarrow\; (1+uv)x = (u+v)t \;\Rightarrow\; x = \left(\dfrac{u+v}{1+uv}\right)t \;\Rightarrow\; x = wt$

Thus in relativity the stationary observer 'sees' the kiddie car moving with velocity

$$w = \frac{u+v}{1+uv}.$$



Velocity w is how fast the kiddie car can move as "*seen from the stationary frame*". Having just developed the law of velocity addition, Susskind shows that the relativist believes that the addition of the two velocities, v and u cannot equal or exceed the speed of light, via

$$w = \left(\frac{u+v}{1+uv/c^2}\right) \;\Rightarrow\; \frac{1.8}{1.81}c \;<\; c.$$

So it appears legitimate, in Susskind's eyes, to accelerate a railcar containing a kiddie car to $0.9c$ with respect to the station, *and then* to accelerate the kiddie car to $0.9c$ with respect to the moving railcar. Physics in Einstein's cartoon worlds differs completely and utterly from reality.

About 27.5 minutes into the lecture I ask about the meaning of '*seen from the stationary frame*':

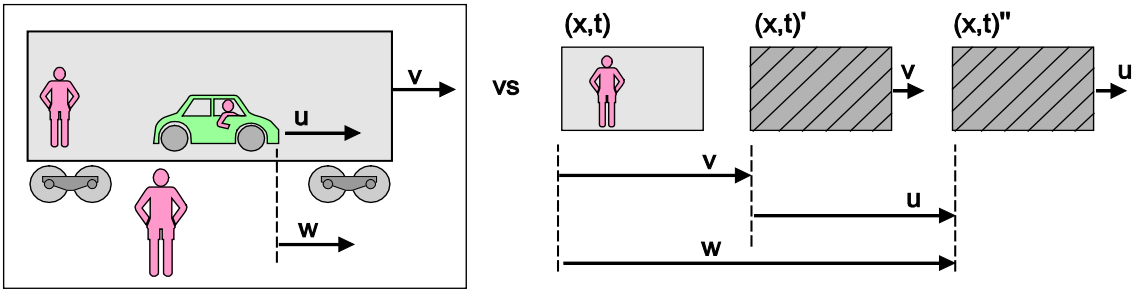
Me: "*The stationary observer sees that through the eyes of x'. What if the train had glass walls so that the stationary observer was looking at both?*"

Susskind: *"If the train had… assume the train did have glass walls. I don't see how that…"*

"We're not talking about appearances. We're talking about what measurements of phenomena by meter sticks and by "well-designed clocks" correlate with each other. What somebody sees is much more complicated. For the simple reason that when an event happens, light has to come from the event and it can be much more complicated what you visually see. We're not talking about which you visually see; we're talking about correlating the locations and times of events in frames of reference which are

> *defined by meter sticks at rest relative to observers and timepieces which are also at rest relative to them."*
>
> "It doesn't matter what kind of walls the car has, *the transformation laws are universal."*

Let's consider the *glass wall* aspect of the problem. My intent is to allow us to see reality as it is, with *the station, the railcar, and the kiddie car*, all of which exist in *objective reality*. Via the glass wall I wish to imply that it is all within our view at once. This contradicts relativity, in which each of the key entities is replaced by a cartoon world, with no cartoon world preferred. We *cannot* perform measurements in the moving railcar or kiddie car; we can only transform event coordinates between frames: $x'' \Leftarrow x' \Leftarrow x$ where $x' = \gamma(v)(x - vt)$, $t' = \gamma(v)(t - vx)$, etc.



Expanding my question to Susskind: "*The stationary observer* [x] *sees* [the kiddie car x''] *through the eyes of* x' [observing in the railcar]", whereas I, the stationary observer, want to look *directly* at the kiddie car with my own eyes (*through glass*); but according to relativists, *time runs differently in inertial frames in relative motion*. If this is the case it is difficult to see how one could, from the station, view inside the railcar and the kiddie car, "*all at the same time*." This would seem to violate the '*relativity of simultaneity*'.

When special relativity is invoked, the ontology of our real world is banished and the ontology of cartoon worlds that represent acceleration-free 'slices' of the real world becomes dominant. In relativity, in the frame of the station, we observe the railcar; and we *cannot* observe the interior of the moving railcar. To observe the interior of the rail car we must invoke the observer in (and at rest with respect to) the moving railcar. Relativity sees only one frame at a time via application of the Lorentz transformation; 'deeper' frames are invisible to the observer. Real physics is lost; in every cartoon world the mass can move at *any* speed less than c. Hence $v = 0.9c$ and $u = 0.9c$ make sense to Susskind, who apparently restricts his vision so that he might affect the critical trade-off of relativity:

Universal time and **universal space** $\Rightarrow$ **universal transformation** on cartoon worlds

Why the Lorentz transformation works

Part of Einstein's genius lay in intuiting that only if $c = constant$ across all reference frames, can the Lorentz transformation even exist. Moving frames with arbitrary velocity are meaningless unless a universal velocity exists to which they can be compared. While $c = constant$ satisfies 4D

geometry, it complicates the physics. It essentially provides a local absolute space by effectively representing ether through which light propagates in the local frame. Rindler [6] saw that:

"Each inertial frame now has the properties with which the ether frame had been credited."

Despite that $c = constant$ is absolutely necessary for Lorentz to work, it still doesn't make sense. He says of Einstein's postulate: *"Light propagates the same in all inertial frames…It is not for us to ask how!*" If it made sense, we *could* ask how; Rindler is admitting that it doesn't make sense.

One might ask, if Lorentz provides a universal transformation enabling us to transform coordinates between any two inertial frames with uniform relative velocity and to prevent the relative velocity from reaching the speed of light, and predicts the slowing down of clocks, then *why complain?* Because, per Susskind [7] "*Special relativity…is counter-intuitive…full of paradoxical phenomena*." "A paradox is a statement that, despite apparently sound reasoning from true premises, leads to an apparently self-contradictory or logically unacceptable conclusion." Wikipedia

In effect, relativists voluntarily give up an *absolute universe* with *universal time* and *universal space* for a *universal transformation* on geometric 4D cartoon worlds. They don't ask what reality looks like directly but simply show that *one can transform from one cartoon world and back*, as often as desired, and as deeply as one wishes, effectively looking "through" a sequence of nested inertial frames. Moving reference frames are not accessible by us; at best we can measure x' radar-like [8] but we, *in* our own rest frame S, *cannot* perform measurements *in* moving frame S'. When compounded by introduction of *another* moving frame S'' we can certainly not perform any measurements from S in S''. We are not even allowed to *see* S''. By virtue of transforming a real physical railcar to a cartoon world, one changes laws of physics in a way that only extended training can make tolerable. As Mermin says, "*some of the things…are hard to believe at first*." Though there's nothing crazy about *energy-time* perspective, based on universal time and space, we are *forbidden to look at it when we invoke relativity* to solve a problem.

Crecraft [10] classifies models: "An *empirical model* starts with the procedure of measurement and observation…an empirical model has no rules of deduction…it uses guesswork, intuition and trial and error to deduce mathematical relationships among the system's observable properties" and lies within the domain of science. A *conceptual model* is an axiomatic system that starts with simple statements and rules of logic that we accept as self-evidently true, and from these it deduces other statements of truth. The postulates are accepted as true, without proof; therefore conceptual models exist within the domain of philosophy rather than science.

Relativity is an *axiomatic model* based on Einstein's relativity axioms, postulates, or principles, which are treated as *truth* and logic used to deduce *other* truths. We *cannot* perform measurements in the moving frame from our observation point in our frame, so relativity is *not* empirical and does not lie within the domain of science.

The ***empirical energy-time theory*** is based in universal time and local absolute space. We measure distance with meter sticks and duration with clocks, and can, in our rest frame, enter and place identical meter sticks and clocks in the railcar (and in kiddie cars) and then accelerate the railcar and its contents to velocity v with respect to the station. Time is seen as the intuitive commonsense notion that it is NOW everywhere in the universe, all at once, with moments in time spanning the entire 3D space. Empirical measurements indicating that *clocks slow down* when moving are compatible with kinetic energy in the empirical model increasing inertial mass.

Apparently believing that conceptual measurement procedures represent *real* (i.e., empirical) *measurements*, and using mathematical logic, Susskind deduces the truth of the *velocity addition law* (which logically follows from the axioms) and ends up convincing himself that the railcar can be given $v = 0.9c$ with respect to the station *and* that the kiddie car can exist in the railcar with velocity (relative to the railcar) $u = 0.9c$ and that the kiddie car is nevertheless prevented from going $w(v,u) = c$ with respect to the rail station. This is *logically perfect, and physically absurd*: ($v = 0.9c$, $u = 0.9c$) instead of ($v = 0.9c$, $u < 0.1c$).

Thus we have two models: an *empirical model* based on measurements in absolute space and time and a *conceptual model* based on axioms that assume the existence of multiple time dimensions; *acceptance of either model implies that the other ontology is not to be taken seriously*. If we believe that $v = 0.9c$ and $u = 0.9c$ makes sense, then their sum is prevented from exceeding the speed of light in the conceptual model. If we believe that $v = 0.9c$ implies that $u \leq 0.1c$ then we do not take seriously nested velocities of $v_j = 0.9c$. As Smolin noted: [17]

> *"to learn relativity is to experience a transition from one way of mentally organizing the world to another."*

Once learned, it is hard to unlearn. Einstein fractured the natural world of absolute time and space; what he did to intuitive awareness is not unlike what happened to Humpty Dumpty. Can a fractured world reclaim integral awareness of nature's integrity? For 115 years there has been no alternative explanation of time-dilation; this now exists. [17] Per McEachern [20]:

> *"…Planck observed a century ago, the problem is, theoretical physicists are not particularly adept at identifying that some things even <u>are</u> assumptions; with the result that 'self-evidently true' facts lead to long periods of stagnation, until these "facts" are eventually shown to be just idealistic false assumptions."*

Einstein did *not* state an axiom to the effect that multiple time dimensions exist; *nor did he clearly state this as an assumption!* He buried the key assumption in the *definition* of *inertial reference frame*, and then formulated *every* problem in special relativity in terms of *two* such frames in relative motion, building in the *false assumption* of multiple time dimensions in a way that usually goes unnoticed. There is *no* problem with the *math* of the Lorentz transformation; the problem is in the ontology, i.e., *the nature of physical reality*. Einstein invented cartoon world ontology, each with its own time dimension and an 'ether equivalent' that guarantees the speed of light is the same in every cartoon world. By declaring $c = constant$ for all worlds, Einstein enabled a *factor* $\gamma = \gamma(v,c)$ allowing one to 'correlate' clocks in worlds via Lorentz.

Computability, predictability, and decidability issues

My take on **computability:** My dissertation [16] (on "*the unreasonable effectiveness of math"*) shows how easily *state machines* come into existence and how *logic structure* makes counters (and hence clocks) and counters lead to algorithms (*next state*). After showing how easy (conceptually) it is to create natural numbers (*successive states*) and assigning numbers to measurements, I review pattern recognition algorithms that *recognize patterns in the measurement data* and lead to 'properties' of the world. Assignment of properties is essentially *epistemology*; the nature of the world is *ontology*. *Assigning properties to the wrong ontology does not make sense*.

This essay shows that 4D-ontology and (3+1)-ontology are incompatible; *energy-time theory* makes different predictions than *space-time theory*. Many nasty problems in physics seem to have little to do with the issues on which this essay contest is based; instead we should focus on ontology, i.e., *physical reality*. Only ontology really 'is', yet is often left up in the air; with efforts focused on mathematics. If one believes that physical reality arises from mathematics, this may make sense. For others, physical reality is a given, which we attempt to model with mathematics. This worked well for centuries. Per James: [18]

> *"Two or more axioms grounded in different ontologies are very likely to prove nothing real about reality, despite having met the proof hurdle within mathematics. (…) mathematics and physics need to be grounded and sorted with ontological consistency, to be able to say anything remotely definitive about reality."*

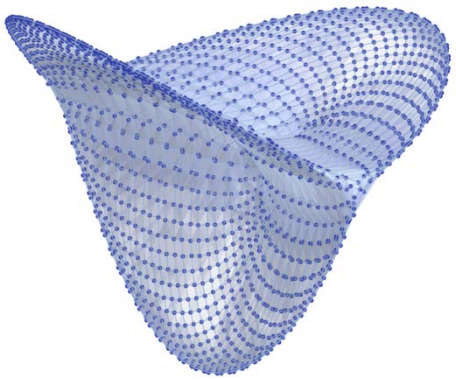
He says one must *"…address the ontological landscape your mathematical or physical theory is necessarily, always within/of…"*. But some physicists think ontology is philosophy, not physics. Non-intuitive paradoxes are explained: "*our brains did not evolve to understand high-speed."* The difference in (3+1)D or 4D-dimensionality is viewed as math rather than as *physically real*. This is *idealistic, not realistic*. One must make *metaphysical choice* commitments to *ontology*:

> *Two different math-based structures can coexist for quite a while,*
> *but only one ontology actually exists.*

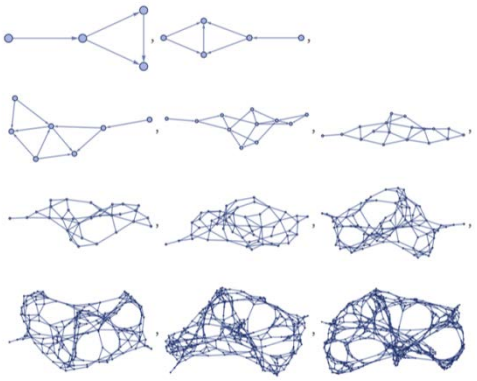
Ontology-based predictions should guide experimental investigations of physics in all fields. Above, we compared cartoon world-ontology in 4D-relativistic space-time with (3+1)D-ontology of absolute space and time. Key is whether the three-space plus time is transformed according to Galilean transformation plus *inertial mass* $m = \gamma m_0$ or according to Lorentz transformation mixing time and space where time expands, length contracts. We derived alternate physical conclusions about relative velocities, based on assumed ontology.

The question of *Knowability* and the Consciousness Field

FQXi's three 'un's limiting our knowledge are undecidability, uncomputability, and unpredictability. Shultz [19] claims that *algorithmic patterns* may be uncomputable or undecidable, but that these limitations do *not* apply to *non-algorithmic patterns* and thus do not impose the limitations of no-go algorithmic patterns on knowability. Feynman: "*more can be known than can be proven.*" This jives with "*non-algorithmic patterns pose no limitation on knowability.*" On April 9 I noted to Schultz that "*human cerebration is not algorithmic*, although it includes logic, i.e. algorithmic patterns, just as *non-linear* includes *linear* in the weak-field case. As many essays treat *know-ability* by invoking consciousness (the topic of my first FQXi essay [20]) I now investigate the issue of how we are conscious of 3-space. For example the figure at right (from Wolfram [22]) is a 3D shape on a 2D plane. How do we consciously perceive it?



To begin, let us assume a *consciousness field* that is *self-aware* and capable of interacting with matter; i.e. able to sense and/or control mass flows. If a mass flow gives rise to a corresponding circulation in the consciousness field, the field *is aware of* this dynamic circulation. The math is simple for mass density flow along a straight line — linear momentum density: $\vec{\nabla}\times\vec{C}=\kappa\rho\vec{v}$. The C-field circulation is proportional to mass density ρ and velocity $\vec{v}$. If we assume a 3D network of non-collinear neurons with flow of ion mass along axons and the flow of vesicle mass across synaptic gaps, *what then does the field look like*, and what is it aware of? Mass-density-based flows of ions in axons and vesicles across synaptic gaps generate circulation in the consciousness field. The endless possible flow patterns inducing local field are 3D and dynamic. Wolfram shows an example of such flows at right [22].

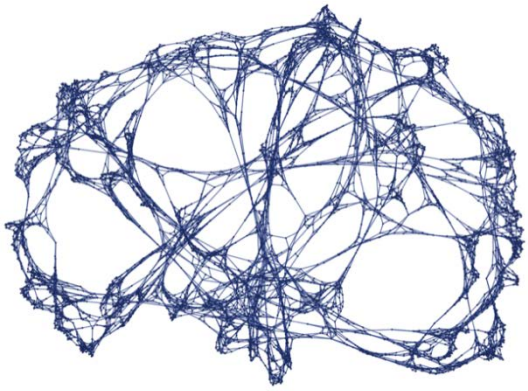


I have postulated the consciousness field [20, 21] to be the source of self-awareness and local awareness based on local flow patterns. Given the flows in a local neighborhood, we can *algorithmically* calculate the circulation in the field at any point in the local neighborhood; and can thereby define the local field configuration at any moment. But the consciousness field is *a real physical field* and thus has energy density, which has corresponding mass flow density $\rho\vec{v}$ when local changes occur in the field, driven for example by the axon flow. This dynamic field mass-flow density superimposes new circulation patterns in the field; this self-interaction introduces non-linearity that makes the field configuration over a volume of the brain a ***non-algorithmic*** pattern which changes over time but supports enduring stable patterns as well.

So C-field circulation is *induced by* momentum density, but the C-field also *exerts force* on mass density flows in the field: $\vec{f}\sim\vec{p}\times\vec{C}\sim\dot{\vec{p}}$. This allows the field to *affect* mass flows in the neural net, and thus to have control in 'shaping' the net. The nature of the consciousness field that fills space is to *be self-aware* and retain self-awareness, and this includes awareness of its self-configuration in 3D space. If the driving field configuration is the local cerebrum [axons and synapses] then one source driving these is visual input focused on surfaces in the 3D world. To produce a 3D shape of flows in neural nets with accompanying changes in the local field, is to be aware of this *non-algorithmic 3D pattern*; we do *not* algorithmically compute 3D from *x*'s, *y*'s, and *z*'s.

> *No other theory of consciousness has the slightest conception of how the x's, y's, and z's of the visual field translate into awareness of 3D shapes (at all scales).*

Thus dynamic mass flows in the brain's countless possible neural dynamic connections (*graphs*) enable 3D field configurations capable of physically approximating any 3D shape; the self-aware field internally models 3D reality we observe [data-driven] or imagine [self-driven]. Once one has mastered the visibly obvious shapes, like box **[]** and ball **O**, one asks how less obvious Klein-bottle-like shapes can occur. If the consciousness field can steer eyeballs through the neural net and understand complex 3D detail, then the field can essentially invoke local shapes at will.



I was considering developing example graphs in *Mathematica*™ to simulate neuron flows and produce non-algorithmic patterns. The flow graph may be algorithmic, but the self-induced C-field configurations are *non-algorithmic*. The non-algorithmic patterns in the dynamically self-interacting field are not logic constrained, but essentially *intuition-based*, a self-awareness that transcends logic relations, as the field is locally dense, but contiguous with the universe. I made these remarks 9,12,13 April 2020 in FQXi comments [23, 24], and on 14 April Steven Wolfram, the genius behind *Mathematica*, published a "*Path to a fundamental theory of physics*"[22]. Based on algorithmic graphs encoded visually as 3D, these graphs begin simply, then combine in more complicated sequences, unfolding the graph that produces 3D-appearing configurations. This relieved me of a lot of work and demonstrated that axon-synaptic flows in 3D can yield almost arbitrary shapes.

Wolfram says the process "*begins with something very simple and very structural, ...a graph*" and "*all that matters is what connected to what*; *…the order in which nodes appear in a hyper edge matters*." Wolfram believes he has a new path to a fundamental theory of physics, and asks "*if we were to run rules like these long enough, will they end up making something that reproduces our physical universe?*" I believe that his model is a primitive model of the possible connections in the brain, and that it is "*what's connected to what*" and "*the order in which nodes appear*" that matters. The axon mass flows from node to node [synapses] induce changes in the consciousness field [missing from his model] and the mind becomes aware of 3D shapes because the 3D shapes are dynamically imposed on the 3D consciousness field in a way that would be impossible without the neural architecture of the brain.

In summary, it is relatively easy to construct 'logic' circuitry in the brain based on neurons, [16] with the consequential algorithmic ability, but no one has provided any explanation of how we are aware of 3D shapes in 3D space, at arbitrary and mixed scales. Suggested micro-tubules are local entities and have no 'global' awareness properties. Quantum fields are sexy, but no models exist that come close to describing the operations of our mind. In a 3D world [see first part of essay] all animals have neural networks of varying size and complexity, and all evolve in a 3D world in which they would not survive without 3D awareness. Only a consciousness field in 3-dimensional space can explain the Universe in satisfactory manner, compatible with Wheeler's Universe, self-aware from the beginning.

Observe that, in many static situations, it is possible and convenient to view the magnetic field, generated by moving charge, as separate and distinct from the electric field, whereas in dynamic situations the two are viewed as aspects of the unitary electromagnetic field. Similarly, when the gravitational field is essentially static, the C-field, induced by moving mass, can be viewed as separate and distinct from the gravity field, whereas in dynamical situations such as occurred at the big bang, the two fields are perceived as a unitary gravitomagnetic field, filling the universe and defining 3D space.

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