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Comparative Ontology of Theories of Space and Time

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Abstract

With a few exceptions, physics theories are based in a conception of time and space; our two major theories, general relativity, and quantum field theory, differ in their conceptions. Key issues herein include mathematics, logic, intuition, experiment, and ontology, with emphasis on simultaneity and dimensionality of the world. The treatment is through ontological comparison of two theories, space-time theory (special relativity) and energy-time theory (local absolute space and universal time). These two theories share many of the same equations but have different ontology.

Keywords

Spacetime Ontology, Comparative Ontology, Local Absolute Space, Relativistic Mass

1. Introduction

Ontology is singular. It is the nature of reality. A theory of physics provides mathematico-logical models of reality that assume an ontology. In fact, different theories assume different ontologies; the success of various of these different theories has caused many physicists to dismiss ontology as "unknowable". I propose that comparative ontology is of value to physics and should be part of the measure of validity of any theory. This paper presents a comparative ontology analysis of a space-time theory and an energy-time theory.

It is generally agreed that [1] "…relativity reveals the nature of time to be shockingly different from what had been taken completely for granted." Despite a century of relativity, this still gives rise to discussion and analysis. Recent papers [2] [3] [4] establish a current picture of the nature of time and space considering "the empirical success of special relativity". Despite the mathematically simple nature of the Lorentz transformation basis of special relativity, Rovelli [5] states that "special relativity is a subtle and conceptually difficult theory." Proportional to associated ontological confusion? Per Thyssen, two debates have been central to philosophy of special relativity:

1) The debate on the conventionality of simultaneity.

2) The debate on the dimensionality of the world.

Both debates have lingered to this day without definite answers and "the link between both debates has remained largely underexplored." I herein identify this link and explore the consequences.

Thyssen states that one of the central questions in the philosophy of special relativity is "the reality question: is only the present real (presentism) or are the past and future equally real (eternalism)? …presentism is a realist thesis …the presentist thesis makes an ontological claim about the nature of time, not epistemological." I review a few recent claims about presentism before addressing issues 1 and 2 above. Golosz [6] examines the relations between presentism and his thesis concerning the existence of "the flow of time". I believe "the flow of energy" relates better to presentism. At every spatial location the present exists, but the change of location, easily measurable, provides a more ontological phenomenon. How does one measure "the flow of time"? Clocks are energy-based and hence the measurement of time is indirect at best. If we continue to observe the flow of energy (matter), it continues to be "the present", and nothing changes that fact. It is unclear ontologically what is meant by the "flow of time" as opposed to present time.

More recently [7] Golosz refutes "Brute Past Presentism" according to which the past is supposed to be both a fundamental and present aspect of reality. This ontological claim addresses the idea that true past-tense claims should not depend on any present aspect of reality. This ontology might be reformulated from "the flow of time" to the "flow of energy"-ontology:

Energy, when it crosses a threshold and effects a change of structure, records information. In essence, the flow of energy halts and the information is present in the record, right now. Information meaningfully exists only in context. For example, "One if by Land; Two if by Sea" is generally meaningless unless one has the context symbolized by Paul Revere. For another example, the context of geological information is geological theories, used to interpret the information. The point being that the past "exists" in the present only through the presence of information assumed recorded in the past and preserved in the present (plus context). This is ontologically compatible with energy-time theory without invoking the "brute past" existence.

The organization of this paper is as follows: In Section 2, we present a mathematical formalism in which two ontological classes are defined: D^{3+1} and 4D spacetime. Section 3 gives a brief overview of time and space ontology. Section 4 introduces the Lorentz transformation in the context of space-time and energy-time theories. In Section 5, both theories relate two inertial frames, primed and unprimed, containing two time entities, t' and t. Via Hestenes' geometric algebra we contrast the meaning of t' in two theories and derive the time dilation relation for inertial clocks. Section 6 explains inertial mass in space-time physics by considering space-time physics as "slices" of energy-time physics. Section 7 uses two classes of theoretical models: empirical and conceptual, to identify our theories. Section 8 compares simultaneity definitions in space-time physics, and energy-time physics. Section 9 describes the logical error Einstein introduced in "*relativity of simultaneity*" and uncovers the source of this relativity in space-time physics—Thyssen's "largely underexplored" link between "conventionality of simultaneity" and "dimensionality of the world". Section 10 introduces the concept of ontology-dependent measurement and formulates an ontology-dependent example. Section 11 analyzes measurements in space-time specific ontology, formulating a framework that leads to the velocity addition law. Section 12 derives the velocity addition law (violated in particle colliders) with emphasis on ontologically interpreting the experiment. Section 13 discusses concepts of measurement involved in the development of the velocity addition law. Section 14 provides ontological comparison of points developed herein. Section 15 discusses alternate descriptions of ontology, while Section 16 discusses ontological understanding.

2. Does Math Determine Ontology?

Thyssen analyzes Rietdijk-Putnam, Weingard-Petkov and other arguments to the effect that "Special relativity necessitates an eternalist, four-dimensional view of reality." With key aspects still unresolved, he concludes that "special relativity leaves the debate on the dimensionality of the world underdetermined." That is, it is uncertain whether time has a unique dimension and space has three dimensions D^{3+1} or space-time is a 4D reality.

One can develop physics for a D^{3+1} universe (*presentism*) or a 4D universe (*eternalism*) in terms of Hestenes multi-vector $X = (ct + \boldsymbol{x})$ based on one's choice of basic assumptions: absolute space and time D^{3+1} or relative space-time 4D and corresponding choice of how to apply the Lorentz transformation [8]. The $X = (t + \boldsymbol{x})$ formulation is Lorentz compatible, but Lorentz-free energy-time theory based on metaphysical assumptions of absolute space and time and inertial mass yields time dilation physics; contradicting the long-held belief that the empirical fact of time dilation is proof of the theory of special relativity. Per James [9]:

> "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. …you need to address the ontological landscape your mathematical or physical theory is necessarily, always within/of…"

Hestenes' employed his structure $X = (ct + \boldsymbol{x})$ to yield momentum and energy relations based on Lorentz transformation to obtain 4D special relativity; the same momentum and energy relations are derived without Lorentz transformation, using a D^{3+1} interpretation of his structure as a vehicle to introduce energy-time theory. Thus, the geometric algebra multi-vector structure $X = (ct + \boldsymbol{x})$ can represent D^{3+1} dimensional physics or 4D physics.

Either we choose metaphysics that supports Lorentz transformation on time and space, or we choose metaphysics of absolute space and time that does not support Lorentz transformation on time and space, but on mass. One choice implies paradoxes, logically unacceptable conclusions; the other choice is paradox-free. The $X = (ct + \boldsymbol{x})$ formalism does not care, physical reality cares.

Analysis of the empirical successes of relativity suggests that time dilation is probably the success most convincing to physicists; we stipulate that time dilation is an established fact, and would remain such had Einstein never existed. The question becomes how to explain time dilation in the classical world of absolute space and time. The physics of absolute space and time produces: $m = \gamma m_0$, $\gamma = \left(1 - v^2/c^2\right)^{-1/2}$ and $H = \left(m_0^2 c^4 + c^2 p^2\right)^{1/2}$. Analysis of inertial clocks shows moving clocks slowing down by factor $\mathrm{d}t' = \mathrm{d}t/\gamma$ ($\omega' = \omega_0/\gamma$), *exactly* matching relativistic time dilation. This interpretation of the fact of time dilation ontologically differs from relativity.

3. Brief Overview of Time and Space Ontology

It is the ontology of time and space that we find non-intuitive about special relativity. Historically man intuitively observed that it is always "now", independently of location in space; the present moment was assumed unconnected from space in an ultimate sense. This changed with Einstein's formulation of special relativity. The following brief metaphorical overview of special relativity ignores historical issues of Maxwell-Hertz, Michelson-Morley, and Lorentz transformation [10], in favor of a simple but accurate picture of what Einstein postulated:

> 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. In addition, space-time symmetry means there is no preferred reference frame.

Relativists always formulate their problems in terms of two or more inertial reference frames, each with its own universal time dimension, related by the Lorentz transformation—a geometric transformation in 4D space-time connecting two of Einstein's 4D cartoon worlds.

Each cartoon world in **Figure 1(a)** has its own space and time, and effectively its own ether, imposing the speed of light on local frames and a uniform relative velocity $\boldsymbol{v}$ between them; each frame has 4D dimensionality. **Figure 1(b)** shows an alternate ontology: D^{3+1}. The big box represents all of space and a universal time dimension covering all of space right now. The two physical frames of interest, one at rest, the other in motion, each have their own spatial map but share a common time. Speed of light is with respect to local absolute space (the big box common to both frames).

4. Analysis of Lorentz in Space-Time and Energy-Time Theories

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 this satisfies 4D geometry, it complicates the physics, essentially providing local absolute space by representing ether through which light propagates in the local frame. If one begins with the photon relation $x = \pm ct$ one can derive $c^2t^2 - x^2 - y^2 - z^2 = 0$. For another photon we have $c^2t'^2 - x'^2 - y'^2 - z'^2 = 0$. If c is constant, then we can relate the two frames in relative motion $v \neq 0$ via the Lorentz group

$$(x', y', z', t') = L(v,c)(x, y, z, t) \tag{1}$$

and inverse transformation: $L^{-1}(v,c) = L(-v,c)$. This group symmetry is characteristic of geometry, and represented by "rotations" in the sense that rotation from $\boldsymbol{x}$ to $\boldsymbol{x}'$ can be reversed by an inverse rotation from $\boldsymbol{x}'$ to $\boldsymbol{x}$. In the same way 3D rotations mix coordinates x, y, and z, relativistic 4D rotations mix three-space and time:

$$\begin{aligned} x' &= \gamma(v,c)(x - vt) \\ t' &= \gamma(v,c)\left(t - vx/c^2\right) \end{aligned} \tag{2}$$

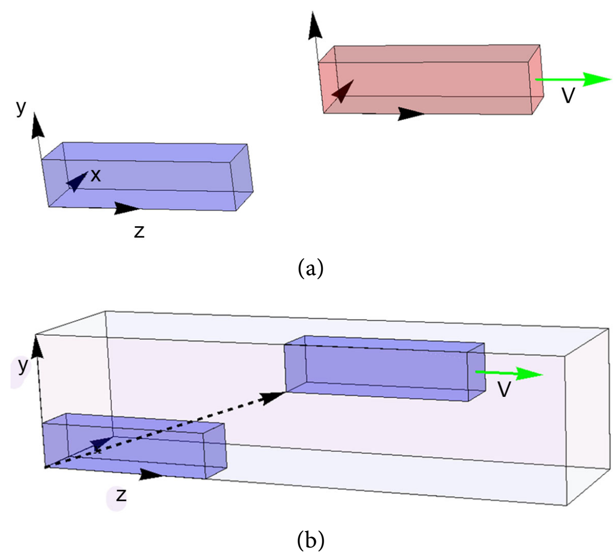

Figure 1. (a) 4D space time ontology; (b) D^{3+1}-ontology of space and time.

This mixing was immortalized by Minkowski: "only a kind of union of [time and space] will preserve an independent reality." The non-intuitive mixing of time and space in 4D is most problematic in relativity, where primed coordinates (x', t') apply in one frame: unprimed coordinates (x, t) in another. To analyze this several questions need be considered: 1) Is c = constant in all frames? 2) What is the meaning of t'? Relativity assumes c = constant in all frames. Classically, this was based on physical properties of the media through which the photon propagates, *i.e.*, the *ether*. Nevertheless, a major contributor to relativity, Rindler [11], saw that in relativity:

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

Despite that c = constant is 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.

Ontologically, relativity banishes the medium of ether and replaces it with the proclamation that it is the local space-time coordinate frame that accomplishes the required invariance. Alternatively, energy-time theory assumes the gravitational field is present everywhere in space. Having energy, the field is material and is the medium through which electromagnetic waves and gravitomagnetic waves propagate. General relativistic problems with gravitational energy are treated elsewhere [12]. The recent discovery [13] that both waves propagate with the same speed is compatible with the assumption of an etheric medium. Propagation of light in this local medium is compatible with both Michelson-Morley experiments and Michelson-Gale experiments [14]. A consequence of propagation in local medium is the violation of Einstein's axiom of constant c in all frames and his claim that one cannot detect the speed of the local frame from within the frame.

5. The Meaning of t' in Space-Time Theory and Energy-Time Theory

The space-time ontology derived from Lorentz is based on 4D-geometry; the ability to transfer from one 4D frame (x, y, z, t) to another frame (x', y', z', t') via Equations (1) and (2). In 4D-space-time geometry basic motion is fixed by uniform velocity $\boldsymbol{v}$ between the frames. Einstein's lack of acceleration removes *force* from the picture; the transformation from an event in one frame to its corresponding event in the other frame is independent of mass, so mass does not appear in the Lorentz transformation. To understand the meaning of this we must interpret the meaning of t'.

In space-time theory t' is the time dimension in the primed frame, different from the t dimension in the unprimed frame; incompatible with physicists' intuition while the energy-time definition of t' is that of time measurement, not time dimension. To understand this, we focus on physical mass.

Hestenes, [15] presenting a new math formalism, desired complete compatibility with relativity:

> "The entire physical content of the relativity theory has been incorporated into our concept of space-time. It is fully expressed by the Lorentz transformation between inertial systems and the invariant interval between events. No dynamical assumptions are involved."

The curious physicist wonders: if relativistic space-time physics is derivable with no dynamical assumptions, can dynamical physics be derived without space-time assumptions? Time-dilation, the key "proof" of relativity, is derived in the ontology of absolute space and time based on Hestenes' multivector formulation: time dilation obtains; clocks do run slower when moving. We analyze this aspect of time dilation, assuming that mass is a function of velocity $m = m(v)$. Mass will thus be lowest when $v = 0$ and this would imply a preferred frame in which mass is minimized. In D^{3+1}-ontology this describes the rest frame S while 4D-ontology assigns velocity zero to *every* object at the origin of the S inertial reference frame: $m \equiv m_0$. In other words, when relativists transform (x, y, z, t) and $(x, y, z, t)'$ they reset the rest mass: $\begin{bmatrix} x = 0 \\ \dot{x} = 0 \\ m = m_0 \end{bmatrix} \Rightarrow \begin{bmatrix} x' = 0 \\ \dot{x}' = 0 \\ m' = m_0 \end{bmatrix}$.

This establishes the time-space 4D-rotation, at the expense of kinetic energy. Mass is reset to rest mass while distance is shortened, and duration is lengthened according to Lorentz transformation, while according to energy-time 3D-rotation it is inertial mass that is transformed by the inertial factor γ, but time and space are Galilean in nature.

$$\begin{array}{cc} \text{Space-time theory} & \text{Energy-time theory} \\ \begin{Bmatrix} m' = m_0 \\ x' = \gamma(v)(x - vt) \\ t' = \gamma(v)(t - vx) \end{Bmatrix} & \begin{Bmatrix} m' = \gamma(v) m_0 \\ x' = x - vt \\ t' = t \end{Bmatrix} \end{array} \tag{3}$$

Lucas and Hodgson [16] make a major point about inertial mass: "If we insist on retaining Newtonian dynamics, and the Newtonian definitions of velocity and acceleration, then we can still obtain relativistically correct results if we pay the price of allowing the mass to depend on the velocity." Checking our Hamiltonian, for inertial mass $m = \gamma m_0$, $E = mc^2$ and $\boldsymbol{p} = m\boldsymbol{v}$ we derive:

$$E = \left(m_0^2 c^4 + c^2 p^2\right)^{1/2} \Rightarrow E^2 = m_0^2 c^4 + c^2 p^2 = m_0^2 c^4 + c^2 \gamma^2 m_0^2 v^2$$

$$\Rightarrow E^2 = \gamma^2 m_0^2 c^4$$

$$\frac{E^2}{m_0^2 c^4} = 1 + \gamma^2 \frac{v^2}{c^2} \Rightarrow \gamma^2 = 1 + \gamma^2 \frac{v^2}{c^2} \Rightarrow \gamma = \frac{1}{\sqrt{1 - v^2/c^2}} \tag{4}$$

In D^{3+1}-ontology the velocity υ of an object is with respect to rest frame S, local absolute space, and any change of υ is via accelerating force: $m\boldsymbol{a} = \mathrm{d}\boldsymbol{p}/\mathrm{d}t = \mathrm{d}(\gamma m_0 \boldsymbol{v})/\mathrm{d}t$ while in 4D-ontology the momentum relation $\boldsymbol{p} = \gamma m_0 \boldsymbol{u}$ is applied where $\bar{u}$ is the velocity of the object in a reference frame, not the velocity of the reference frame relative to another.

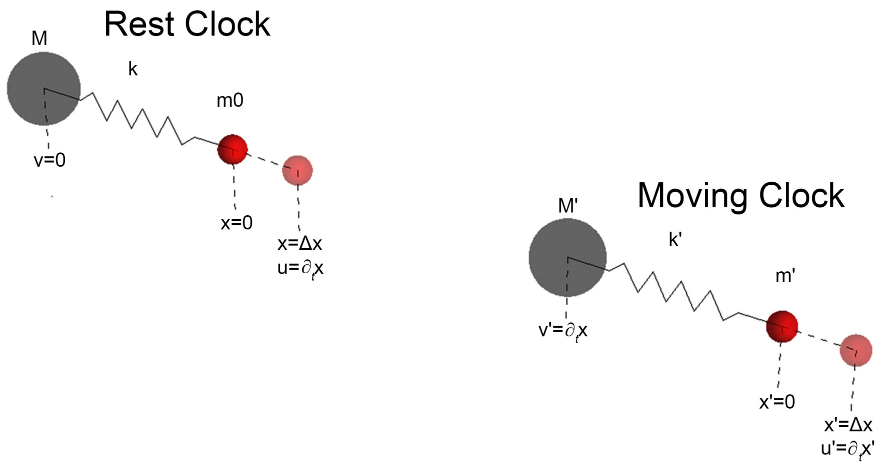

Figure 2. Diagrams with relevant parameters for rest and moving clocks.

D^{3+1}-ontology preserves the spirit of relativity, which is to preserve physics across frames, so we write the physics in S and S frames:

$$\frac{\mathrm{d}\boldsymbol{p}}{\mathrm{d}t}=-k\boldsymbol{x}\,,\quad \frac{\mathrm{d}\boldsymbol{p}'}{\mathrm{d}t'}=-k'\boldsymbol{x}' \tag{5}$$

"Physics of clocks in absolute spacetime" derives the algebra necessary to equate these two equations in universal time:

$$\frac{\mathrm{d}p'}{\mathrm{d}t'}\Rightarrow\frac{\mathrm{d}^2x'}{\mathrm{d}t^2}+\left(\frac{\omega_0}{\gamma}\right)^2x'=0\Rightarrow\ddot{x}'+\omega'^2x'=0 \tag{6}$$

$$\frac{\mathrm{d}p}{\mathrm{d}t}\Rightarrow\frac{\mathrm{d}^2x}{\mathrm{d}t^2}+\omega_0^2x=0\Rightarrow\ddot{x}+\omega_0^2x=0 \tag{7}$$

In terms of universal time t, the equation of motion of the rest clock yields frequency ω_0, while the frequency of the moving clock is $\omega'=\omega_0/\gamma$, establishing time dilation for inertial clocks in relative motion in D^{3+1}-ontology. This agrees with physical intuition: increased inertial mass leads to decreased acceleration hence lower velocity; the system slows down. In the rest frame of energy-time theory inertial mass has rest mass m_0. If another frame, initially at rest in our frame, is accelerated to velocity υ, its associated inertial mass increases: $m=\gamma(\upsilon)m_0$. Intuition vanishes the moment special relativity is invoked; the space-time symmetry principle forbids preferred frames, so rest mass is not associated with any frame, but with every frame. An observer in the moving frame sees rest mass m_0. The time dilation derived from the physics of clocks in relative motion in D^{3+1}-ontology fails in 4D-ontology, since the no preferred frame axiom of 4D-ontology, given two inertial frames, makes it impossible to tell which is at rest or closer to rest, and therefore, to tell which mass is greater. Thus, relativistic momentum $\boldsymbol{p}=\gamma m_0\boldsymbol{u}$ is based on $\boldsymbol{u}$ relative to an observer, to distinguish it from relative velocity $\boldsymbol{\upsilon}$ between observers. The two clock mechanisms treated in D^{3+1}-ontology (see **Figure 2**) are in different frames, differing by velocity $\boldsymbol{\upsilon}$.

6. Mass in Space-Time versus Energy-Time Theory

Einstein essentially invented "slices" of physical reality in which the objects of interest move with uniform velocity with respect to each other. Einstein excluded from his theory the periods of physical acceleration necessary to provide the relative velocity to objects initially at rest in a local frame and mapped 4D-ontology into "slices" of D^{3+1}-ontology as seen in **Figure 3**. The velocity curve shows constant relative velocity of relativity as shaded regions, while the acceleration portions of the curve exist only in D^{3+1}-ontology.

This automatically excludes all inter-frame kinetic energy, allowing him to, impossibly, "reset" the inertial mass of the moving objects to their rest mass by "switching" the observer from one frame to the other (conceptually easy, physically impossible). Formally, this is the result of space-time symmetry, his key postulate that there is no preferred frame, which enables geometric transformation from one frame to the other and back, but makes it is impossible to tell which inertial frame is stationary and which is moving.

The physics of two clocks in absolute space recognizes the difference in kinetic energy, hence equivalent mass; the increased mass is responsible for the moving clocks "slowing down". Time dilation in relativity is not derived from the physics of real inertial clocks operating in universal time but is conceptually tied to different time dimensions in different inertial reference frames. Recognition of the relativistic "reset" $m(\upsilon) \to m_0$ of mass as the basis of the inertial reference frame, may have caused Okun [17] to state "The terminology [relativistic mass] has no rational justification today", while Rindler and others retained it as a useful concept.

The actual nature of the relativistic mass does not change the logic of our argument. An excellent case can be made that the kinetic energy of motion is stored in the C-field circulation induced by $\boldsymbol{p} = m_0 \boldsymbol{v} = \int \mathrm{d}^3 x \nabla \times \boldsymbol{C}$. The force, $\boldsymbol{F} = \mathrm{d}\boldsymbol{p}/\mathrm{d}t$ ~ change in circulation that accelerates the mass between "slices" changes the momentum, and hence the kinetic energy ~ $\boldsymbol{p}^2/2m$.

7. Theoretical Models

In this paper, we compare two theories, each with its ontology: a theory of absolute time and space, derived from a structure of time and space devised by Hestenes:

> "Everything we know about physical space-time is known through its representation by some model, so when we are thinking about space-time and its properties, we're actually thinking about the model. (…) however, we attribute an independent existence to space-time which might not be accurately represented by our model (…) so we must keep the distinction clear when considering the possibility that the model is wrong."

Since Hestenes' basic structure can be developed in either ontology, we further classify theories according to Crecraft [18], who divides models into empirical and conceptual models:

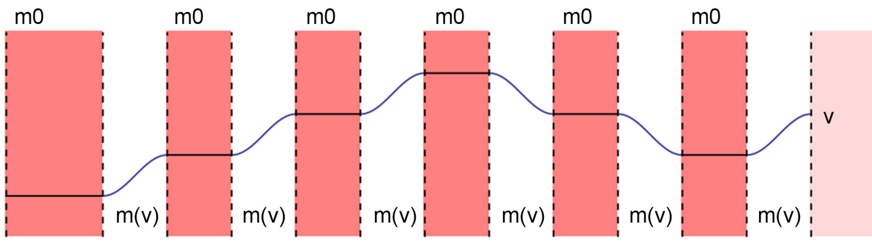

Figure 3. Map 4D-ontology onto "slices" of D^{3+1}-ontology.

> "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.

The space-time theory of 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. The truths are logical, according to the axioms, but they are non-intuitive (nonsensical) in a physical ontology with acceleration forces, Thyssen declares the debates central to the philosophy of special relativity.

The energy-time theory of universal time and local absolute space is an empirical model, based on measurement and observation, limited to our real objective world. The theory treats time as the intuitive commonsense notion that it is NOW everywhere in the universe, all at once; one moment passes into the next moment; moments in time span the entire three-dimensional space, intuitively jiving with common experience. Measurements that indicate that clocks slow down when moving are compatible with kinetic energy in the empirical model with increasing inertial mass. Similar analysis applies to electromagnetic aspects of relativity. Analysis of measurement in the two theories is presented in the section dealing with velocity addition.

Where does the conceptual relativity model lead? In one example, Mermin posits two opposing trains of moving rocket ships whose various clocks have been "deliberately set out of synchronization"; but observers on the rockets are assured that clocks in other rockets are synchronized. He then contrives a situation in which "occupants of each of the two trains being firmly convinced that it is the clocks on the other train that are running slowly." Mermin concludes that "once one introduces the asynchronized clocks on each train, all the other relativistic effects follow automatically." Whatever his purpose, Mermin concludes about time:

> "…the concept of time is nothing more than a convenient…device for summarizing compactly all relationships holding between different clocks."

In a current relativity paper [19]: "Persons A and B define two distinct inertial frames of reference, corresponding to different spacetime conditions (with) different lengths of meter and durations of second…as predicted by Lorentz." and "Time dilation symmetry arose as a logical deduction of Einstein's 1905 postulates: if two clocks occupying two distinct inertial frames of reference are in relative motion, each one is expected to run slower than the other." However, the authors state that many experiments (including GPS) seem to confirm that time dilation is an asymmetric phenomenon. One might think that experimental contradiction of logical deduction from the axioms would discredit the axioms, but they conclude: "It is assumed that time and 3D space do not exist as separate features of the universe but form a 4D continuum known as spacetime."

So, spacetime theory deduces that each clock runs slower than the other one, while energy-time theory predicts that the accelerated clock will run slower than the rest frame clock. Hafele-Keating experiments resolve the issue experimentally. One can choose a paradox-free empirical theory of absolute local space and universal time with real empirical results, or a paradox-laden conceptual theory of worlds connected by a 4D "universal transformation" between worlds.

8. The Ontology of Simultaneity

Rovelli notes that there is no device that will detect "now", a concept missing from 4D-ontology. Thus, despite that in relativity the concept of simultaneity is replaced by relativity of simultaneity, there is no general means of determining distant simultaneity. Per Rovelli: "Relativity is not the discovery of a new ontology of simultaneity; it is the discovery that there is no fact of the matter, whether two distinct punctual events happen at the same time or not." Einstein chose to invent multiple time dimensions, making use of Lorentz transformation and making a metaphysical commitment, defining 4D space-time symmetry as ontology. If one commits to D^{3+1} with universal simultaneity (*now*) one commits to a metaphysics and defines an ontology—the metaphysical assumptions Thyssen claims are needed to answer the question of reality. Relativity replaces the concept of simultaneity by relativity of simultaneity yet does not present us with ontological fact; it claims that distant simultaneity is not measurable, hence not a provable ontological fact. Neither can Einstein's proposed ontology be measurably proved; we are left with ontological non-facts.

As "simultaneity" is key, we pay particular attention to how Einstein [20] defined simultaneity:

> "we must require a definition of simultaneity such that the definition supplies us with the method by means of which…(we) can decide by experiment whether or not the lightning strokes occurred simultaneously. (…) an observer should be placed at the midpoint [between lightning flashes]. …If

> the observer perceives the two flashes of lightning at the same time, then they are simultaneous."

"are two events (e.g., the two strokes of lightning A and B) which are simultaneous with reference to the railway embankment also simultaneous relatively to the train? …lightning strokes A and B are simultaneous with respect to the embankment [if] the rays of light emitted at the places A and B, where the lightning occurs, meet each other at the midpoint of the length AB…" "Let M' be the *midpoint* of the distance AB on the traveling train. Just when the flashes occur [judged from the embankment] this point M' naturally coincides with the point M, but it moves [toward the right] with the velocity v of the train."

If an observer sitting in position M' in the train did not possess this velocity (then) light rays emitted by the flashes would reach him simultaneously (…) Now in reality (…) he is hastening toward the beam of light coming from B, whilst he is riding on ahead of the beam of light coming from A. Hence the observer will see the beam of light emitted from B earlier than he will see that emitted from A. We thus arrive at the important result:

> "Events which are simultaneous with reference to the embankment are not simultaneous with respect to the train, and *vice versa* (relativity of simultaneity)."

Einstein began by requiring a definition of simultaneity capable of deciding by experiment whether both lightning strikes occurred simultaneously; he solved this problem by placing the simultaneity detector (observer) at the midpoint between the two strokes, A and B. He says:

> "There is only one demand to be made of the definition of simultaneity, namely that in every real case it must supply us with an empirical decision. (…) That my definition [of simultaneity detector] satisfies this demand is indisputable."

It is disputable if one requires a meaningful empirical decision. The detector must be at the midpoint when event detection occurs, not when the event occurred. Ideally, at both occurrences.

9. The Built-In Error: Einstein's "Simultaneity Detector"

Einstein's method is based on the simultaneity detector being exactly at the midpoint between flashes. If this is satisfied, the instrument works perfectly, but, according to him, the instrument on the train is moving away from the midpoint. As soon as the instrument moves away from the midpoint, it ceases to function as a simultaneity detector! It is effectively "broken", and any signal from the broken detector is meaningless. As the detector on the train is not midway between the two lightning strokes when it sees the light from B, it is not a properly working detector and its signal is meaningless. This logic is clear. Einstein defines the perfect instrument and then deviates from the definition. It does not thereby become merely an imperfect instrument; it becomes an invalid instrument, and its measurements are meaningless as empirical decisions.

> Yet on this basis Einstein proposes to overturn the accepted nature of time as universal simultaneity and replace it with "the relativity of simultaneity".

Perhaps he understood that multiple time dimensions precluded meaningful simultaneity and therefore felt no need to check his logic. However, logical flow is everything in axiomatic theory, and faulty logic [failure to recognize a "broken detector" away from midpoint] appears to lead to the discovery of the "relativity of simultaneity", the hidden false assumption of relativity built into the definition of "inertial reference frame" and the formulation of relativity in at least two frames, hence at least two universal time dimensions. As noted, "there is no fact of the matter, whether the two distant punctual events happen at the same time." The truth of this statement has no bearing on the logical error of Einstein's simultaneity detector. Einstein's logical error in his simultaneity measurement experiment is independent of the dimensionality of the world; the detector is broken whatever the dimensionality. Although one must determine the midpoint of the distant events before one can measure the "simultaneity" this is in general an impossible task. In the very special case of "lightning flashes on railroad", one can substitute manmade flashes for lightning and trigger these from the midpoint; practical issues of signal distribution and timing that must be solved, but these do not correct Einstein's logic error. The unbroken stationary detector is and remains in the station midpoint between the two strikes and judges the strikes to be simultaneous. In summary: only detectors at the midpoint between two luminal events can detect simultaneity.

By defining his faulty "simultaneity detector" instrument and employing it in the station and on the railcar to detect simultaneous lightning flashes, Einstein "derives" the relativity of simultaneity using the broken instrument which moves away from the midpoint. In fact, relativity of simultaneity is not measured or derived, it is assumed, via the definition of each inertial reference frame possessing its own universal time dimension, per Rindler:

> "An inertial frame is one in which spatial relations, as determined by rigid scales at rest in the frame, are Euclidian and in which there exists a universal time…[such that Newton's laws of inertia hold.]"

A century has passed with little notice of the error of Einstein's logic. One assumes that the ontological confusion of 4D combined with empirical successes such as time dilation convinced many that his logic must hold in cartoon worlds. It does not. Relativists have argued for "two sets of lightning strokes", one in the rest frame and one in the moving frame, but Einstein clearly has both simultaneity detectors measuring the same flashes, occurring in the rest frame. Instead of a boxcar, think flatcar, open to the same sky as the rest frame observes. In relativity the moving observer believes he is at rest, so may think he remains at the midpoint, but Einstein explicitly states that he is moving toward one stroke and away from the other. Relativity of simultaneity follows from multiple time dimensions, not from Einstein's simultaneity detector example, where it is proclaimed. This does not imply that the idea of a simultaneity detector is invalid, only Einstein's use of the detector in his derivation.

In a system where the detector is always at the midpoint of the system, his logic is valid. For example, in Figure 4(a) each frame has mirrored walls with both light source and light detector midway between the mirrors; this system will detect the simultaneity of the flash (from the LED) by registering the simultaneous arrival of the reflected rays at the detector (DET). This is easy to show for a frame at rest, as both rays will travel the same distance, and return to the center at time $t = L/c$. In fact, in energy-time theory, the simultaneity detector works in the moving frame, moving in the local ether of the rest frame. Despite that the light does not move at constant c, but at $c \pm v$, where v is the velocity of the moving frame with respect to the frame at absolute rest, the variable speed light rays (whose speed is dependent on direction) will return to the detector at the same time, $\tau = \frac{L}{c}\left(1 - \frac{v^2}{c^2}\right)^{-1}$, where the time depends on velocity. A key principle of special relativity is that one cannot measure velocity v of the frame by *any* experiment performed within the frame, yet that is exactly what we have done:

$$v = \pm c\sqrt{1 - \frac{L}{c\tau}}. \tag{8}$$

Our simultaneity detector here thus also functions as a velocity meter capable of measuring v.

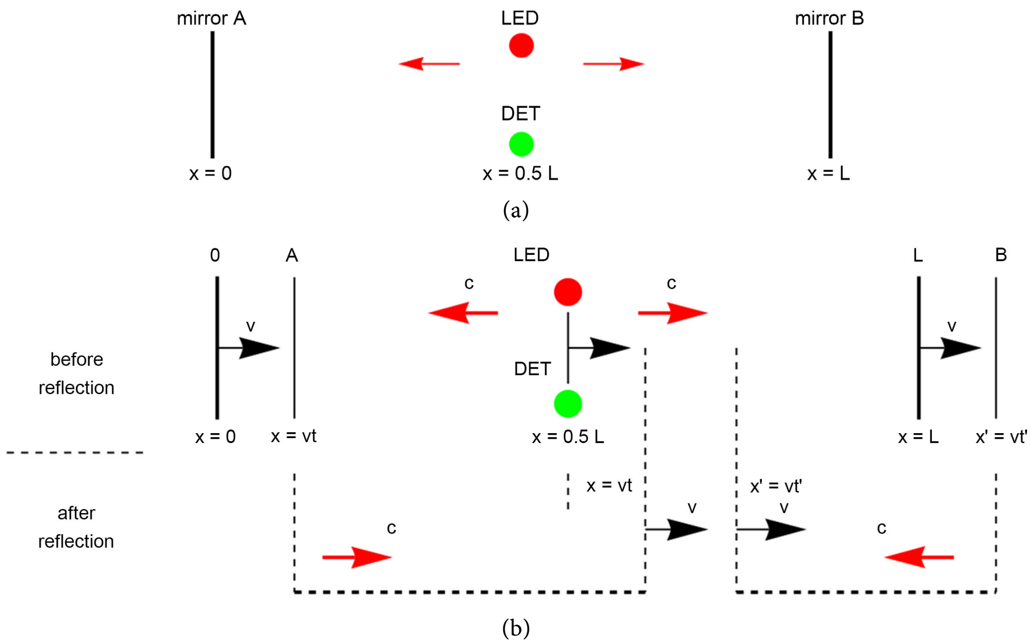

Figure 4. (a) Simultaneity detector system; (b) The system in inertial frame moving with velocity v.

Dace, in [21] argues that Einstein mis-labeled the "relativity of synchrony" as "the relativity of simultaneity" and thereby implied that "this effect concerns an actual difference in times from one frame to another, rather than merely a failure of clock synchronization across frames." From this he concludes that "special relativity fails as a theory of time on the basis of the relativity of simultaneity." Interestingly, he concludes that as a theory of length contraction and time dilation based on frames in relative motion, special relativity is the definitive interpretation of the Lorentz transformation and provides the correct explanation of relativistic phenomena. As analyzed in Sections 4 and 5, we show that "time dilation" in Energy-time theory is simply the slowing of accelerated clocks due to the equivalent mass increase associated with kinetic energy and is not properly a "relativistic phenomenon". Nor is it evident that length contraction actually exists; it has never been measured. In Section 13 we briefly introduce Jefimenko's analysis of "retardation" and "relativity", in which he concludes that relativistic length contraction does not exist.

10. Ontology-Dependent Measurement

Metaphysical assumptions underlying measurements in 4D-ontology versus measurements in D^{3+1}-ontology are ripe for analysis. Relativity excludes acceleration between frames. It has of course been mathematically extended or "continued" into non-inertial domains for reasons of necessity (for instance, the Michelson-Gale experiment), but little or no ontological analysis has been performed in this regard. In either ontology, empirical measurement of inter-frame velocity υ is accomplished using radar and returning pulses are interpreted. Apparent length contraction of the Doppler variety is found, but no Lorentz length contraction. Measuring inter-frame velocity is easy; performing physical measurements inside the moving frame from our rest frame position using meters and time clocks is impossible.

Contrast the 4D-ontology measurement procedure (to be described) with the D^{3+1}-ontology in which both frames are initially at rest in the station, where stationary observers can go inside the railcar measuring distances and durations and calibrating and syncing measurement devices. After the preparation period the railcar is accelerated to velocity v and measurements made. Empirical measurements performed in 3D-space in the stationary frame are real. They are also performed in the moving frame, which has already been measured during preparation.

The following problem illustrates the difference in measurements in 4D space-time theory versus D^{3+1} energy-time theory. A moving frame is assumed to have velocity $\upsilon = 0.9c$ as measured in the stationary frame by the radar method; compatible with both 4D-ontology and D^{3+1}-ontology. The problem is complicated by adding another inertial frame, attached to an object moving inside the moving frame. To be compatible with Leonard Susskind [22] we label the object inside the railcar a "kiddie car" and assume that a third observer exists inside the kiddie car. The stationary frame is labeled *S*, the railcar is S' and the kiddie car is S''.

11. Measurement in Three Frames in Different Ontologies

In order to contrast energy-time ontology of absolute time and space with space-time ontology of special relativity, we formulate a problem in absolute ontology and compare it with relative ontology as follows: The railway station is located in an absolute spatial frame, *S*, and a local railcar, initially at rest in the station, is accelerated until it reaches velocity υ with respect to *S*. The frame of the moving railcar is S'. Rest frame events are labeled by $(t, \boldsymbol{x})$, but can be relabeled in frame S', now uniformly moving with respect to our absolute rest frame. That is, an x, y, z map located at the origin of the entity (railway car) is in motion with respect to absolute space. From the definition of inertial mass $m = \gamma m_0$ mass becomes infinite as $v \to c$, therefore it is impossible to accelerate any mass to the speed of light despite that how close we *can* come is a function of the energy available for accelerating. Here we assume specifically that we can accelerate the railway car to 0.9*c*, 90% of the speed of light. This is certainly legitimate in a universe of absolute time and space.

We then put the kiddie car inside the moving railcar and follow Leonard Susskind's Stanford video series as seen in **Figure 5**. The kiddie car is initially at rest in the railcar, but, after acceleration of the railcar, it will have velocity $\boldsymbol{v}$ in the absolute frame of the railway station. Now we wish to accelerate the kiddie car in the railcar frame.

In our absolute frame (the station) the kiddie car is already moving at 0.9*c* when we begin acceleration relative to the railcar. We cannot increase the speed *u* of the kiddie car (relative to the railcar) to 0.1*c*, else the kiddie car will have been accelerated to light speed in absolute space

$$\upsilon = 0.9c, u = 0.1c \Rightarrow (\upsilon + u) = c. \tag{9}$$

This is *not* the physics of relativity. In relativity, the act of placing the kiddie car inside a moving railcar switches us from D^{3+1}-ontology to 4D-ontology. Susskind says that we can accelerate the kiddie car to at least 0.9*c* relative to the railcar, which is itself moving at 0.9*c* in absolute space. That is, the observer in the relativistic railcar (with $\upsilon = 0.9c$) feels himself to be at rest and places no constraints on the velocity of objects (such as the kiddie car) in his frame. Material objects in his frame can move at any velocity, almost to the speed of light. To limit the velocity because of another "preferred" frame is to violate relativity.

12. Velocity Addition Law

Susskind, in his relativity lecture two, 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,

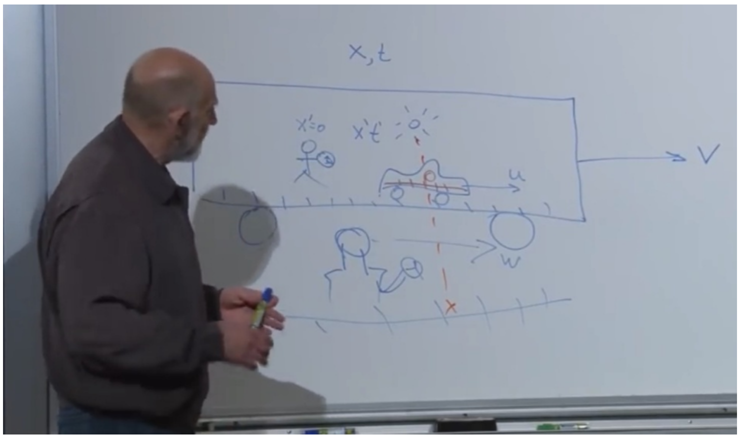

Figure 5. Susskind's formulation of velocity addition law.

$$x' = \frac{x - vt}{\sqrt{1-v^2}} \quad t' = \frac{t - vx}{\sqrt{1-v^2}} \quad c \equiv 1$$
$$x'' = \frac{x' - ut'}{\sqrt{1-u^2}} \quad t'' = \frac{t' - ux'}{\sqrt{1-u^2}}. \tag{10}$$

Plug x' into x'' in terms of t:

$$x'' = \frac{x - vt}{\sqrt{1-v^2}\sqrt{1-u^2}} - \frac{u(t - vx)}{\sqrt{1-v^2}\sqrt{1-u^2}} \Rightarrow \frac{(1+uv)x - (v+u)t}{\sqrt{\ }\sqrt{\ }}$$

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

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

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

Speed w is how fast the kiddie car can move as "seen from the stationary *frame*". In Figure 6, having just developed the law of velocity addition, Susskind shows that relativists believe that addition of velocities v and u cannot reach speed c:

$$w = \left(\frac{u+v}{1+uv/c^2}\right) \Rightarrow \frac{1.8}{1.81}c < c. \tag{11}$$

In Susskind's view, we 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. About 27.5 minutes into the lecture, I ask about the meaning of "seen from the stationary frame":

Klingman:

"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.

Klingman: 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. The glass wall implies it is all within our view at once. But in relativity each of the three 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 sequentially between frames: $x'' \Leftarrow x' \Leftarrow x$ where $x' = \gamma(v)(x - vt)$, $t' = \gamma(v)(t - vx)$, etc. See Figure 7.

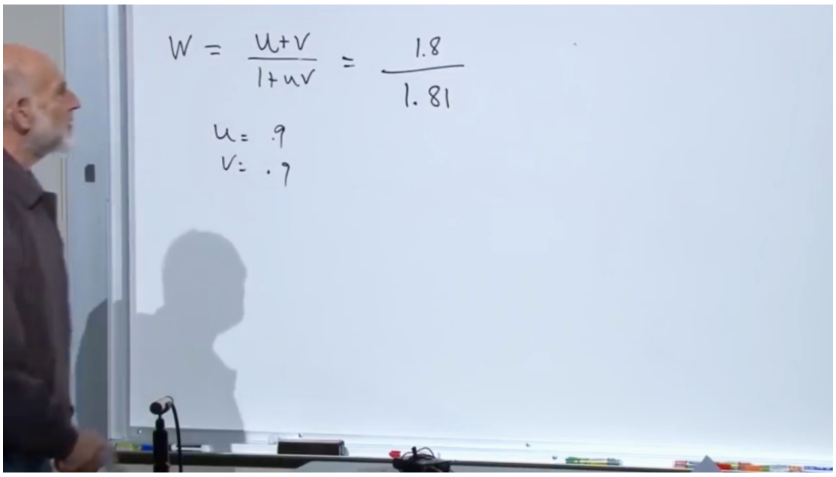

Figure 6. Lorentz summing of velocities.

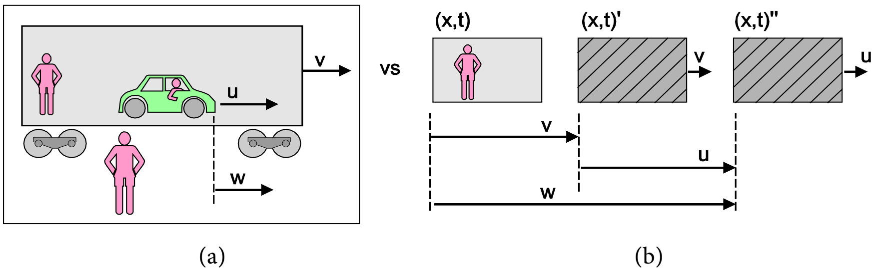

Figure 7. (a) D^{3+1}-ontology representation; (b) 4D-ontology of special relativity.

My point 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); according to relativists, time runs differently in inertial frames in relative motion. To view, from the station, both inside the railcar and inside the kiddie car, “all at the same time” would violate “relativity of simultaneity”.

Contrast the essence of special relativity with the classical idea of universal time: God sees everywhere at one instant of time; time as a one-dimensional parameter appears everywhere throughout classical mechanics, reinforced by direct experience of encompassing a wide region of space with a single glance. The moment we invoke special relativity classical real-world ontology is banished; the cartoon world ontology representing acceleration-free “slices” of the real world becomes dominant. Relativistically, in the frame of the station, we observe the railcar; we cannot observe the interior of the moving railcar. To observe the interior of the rail car we must invoke the observer in the moving railcar. Relativity sees only one frame at a time via application of the Lorentz transformation; “deeper” frames are invisible to the observer; in every cartoon world the mass can move at any speed less than c. Hence $\upsilon = 0.9c$ and $u = 0.9c$ make sense in relativistic ontology, in which one effects the critical trade-off of relativity:

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

Per Susskind [23]: “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

Relativists give up an absolute universe with universal time and space for a universal transformation on geometric 4D worlds. Not asking what reality looks like all at once (through glass walls) they 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 but we, in our own rest frame S, cannot perform measurements in moving frame S'. When compounded by the introduction of another moving frame S'' we cannot perform any measurements from S in S''; in relativity we are not even allowed to *see* S''. By transforming a real physical railcar to a cartoon world, one resets laws of physics in a way that only an extended period of training makes tolerable. Per Mermin: “some of the things…are hard to believe at first.” They are eventually accepted by relativists who have learned to think in cartoon worlds. Per Smolin: [24]

> “To learn relativity is to experience a transition from one way of mentally organizing the world to another.”

In contrast, there is nothing paradoxical about the energy-time perspective, based on universal time and space, it's just that we are forbidden to look at it when we invoke relativity to solve a problem. For instance, Rindler notes that the special relativistic treatment of velocities is problematical:

> "Thus, if a light signal recedes from me and I transfer myself to ever faster moving frames in pursuit of it, I shall not alter the velocity of that light signal relative to me by one iota. This is totally irreconcilable with our classic concepts of space and time."

Thus, universal light speed enables the use of Lorentz rotations on cartoon worlds and Lorentz transformation prevents an object (or frame) from equaling or exceeding the speed of light. However, Cannoni [25] observes that the law of velocity addition is not absolute:

> "Explicitly or tacitly, in high-energy physics literature it is an accepted fact that the relative velocity of two particles can be larger than the velocity of light. …this is a macroscopic violation of the principles of relativity."

If reality violates relativity, then relativistic ontology is false. The "velocity addition law" has no problem with the Lorentz transformation *math*; the problem is ontological, *i.e.*, physical reality. Yet, believing that these procedures represent real measurements, and employing mathematical logic, relativists deduce the truth of the velocity addition law from the *axioms* and end up believing that the railcar can be given $\upsilon = 0.9c$ 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 kiddie car is prevented from going $w(\upsilon, u) = c$ with respect to the rail station. This view is logically perfect, and physically absurd: ($\upsilon = 0.9c$, $u = 0.9c$) instead of ($\upsilon = 0.9c$, $u < 0.1c$). In D^{3+1}-ontology we can measure the velocity of S' and S'' from absolute frame *S*. In 4D-ontology we can measure the velocity of S' from *S* but cannot measure the velocity of S'' from *S*, as there is no radar mechanism that matches the value obtained via the relativistic velocity addition law.

13. Aspects of Relativistic Ontology

Einstein's axioms provide a well-defined conceptual model that is not empirical. Why do physicists seem to view it as if it were empirical? Susskind states that we are: "correlating 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."

In relativity observers in cartoon worlds make measurements via identical meter sticks and clocks in their rest frame as we have in our rest frame; measurements are correlated through Lorentz transformation effecting a 4D geometric rotation on (x, y, z, t) into $(x, y, z, t)'$ to transform our meter stick into the moving frame where it can conceptually make measurements. We cannot reach into a moving frame to measure anything, but our meter sticks measure distance differences $x_1 - x_0$ (1 meter) and time differences $t_1 - t_0$ (1 second) in our rest frame; these standard differences for measuring space and time in reality can be Lorentz transformed as coordinates into a moving cartoon frame in which moving rods become shorter, moving clocks stretch time. Relativists accept abundant evidence of time dilation as proof of relativity and assume length contraction to also be true, generally unaware that clock slowing can occur in local absolute space.

Jefimenko [26] concludes that "…as a physical phenomenon relativistic length contraction does not exist." Initially, length contraction was assumed to represent an effect on a body moving through the ether. However, while rejecting the reality of ether, Einstein accepted length contraction of moving bodies as an observable effect. But length contraction has never been measured, and, per Rindler, probably never will be. The math of Lorentz transformation suggests that to compensate for *time increasing* in a moving system, it is necessary for space to decrease, *i.e.*, length to contract. In Energy-time theory time does not increase; the measure of time, based on physical clocks slowing down, explains why "moving clocks run slower".

14. Ontological Comparison

We have two theoretical 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 generally implies that the other ontology is not to be taken seriously. If we believe that $\upsilon = 0.9c$ 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 $\upsilon = 0.9c$ implies that $u \le 0.1c$ then we do not take seriously nested velocities of $\upsilon_j = 0.9c$. Nevertheless, the existence of two theories of space and time suggests F Scots Fitzgerald's remark:

> "The test of a first-rate intelligence is the ability to hold two opposed ideas in mind, at the same time, and still retain the ability to function."

concerning the ability to hold two ontologies in mind at the same time and retain the ability to function. By function we mean solve problems in either ontology, with its corresponding theory.

Relativity yields length contraction, energy-time theory does not. Relativity is space-time symmetric; energy-time theory specifies a preferred frame. The relativistic observer cannot detect his velocity from within his frame, whereas energy-time theory does allow measurement of absolute local velocity. Both theories agree on "time dilation", but the physical explanations differ.

Most significant: definitions of inertial mass, energy-momentum relations, and the Hamiltonian are the same, whether derived in the energy-time physics of absolute time and space or in Einstein's worlds governed by space-time physics of special relativity! An organized comparison in **Table 1** shows that, with some qualifications, features of reality exactly match the features of the Energy-time theory of physics, whereas only the Hamiltonian and the clock slowing of space-time theory agree with reality.

Table 1. Ontological features of theories of space and time.

Feature of theory	Space-time	Energy-time	Reality	Remarks
Relativistic mass: $m = \gamma m_0$	-	+	+	
Time dilation = f(direction)	-	+	+	Hafele-Keating experiments
Hamiltonian: $E = \left(m_0^2 c^4 + c^2 p^2\right)^{\frac{1}{2}}$	+	+	+	Derived in Hestenes' calculus
Time dilation (clock slowing)	+	+	+	All experiments
Speed $c = c'$ (in all frames)	+	-	-	Michelson-Gale experiments
Length Contraction	+	-	(-)	Unmeasured, unlikely
Time dilation (symmetric)	+	-	-	GPS experiments, etc.
Velocity Addition Law	+	-	-	Cannoni
No preferred frame	+	-	-	Michelson-Gale experiments
Past-present-future	+	-	(-)	Unmeasured, unlikely 4D
Twin paradox	+	-	-	
Barn/pole paradox	+	-	-	
Grandfather paradox	+	-	-	

Assumptions made in Table 1 concerning features of reality: if reality is unknown because unmeasured, the believed state of reality is in parentheses. All paradoxes are assumed to be unreal.

15. Alternate Descriptions of Ontology

The comparison between space-time physics (special relativity) and energy-time physics (absolute space and time) clearly contrasts major aspects of the theories but does not exhaust the possibilities. For example, consider Jefimenko's work: rather than formulate a new theory, Jefimenko simply observes that, since electric and magnetic fields propagate with finite velocity, there is always a time delay before electromagnetic conditions initiated at a point of space can produce an effect at any other point of space. The time delay is called electromagnetic retardation. Evolved from Maxwell's equations, this leads to electromagnetic relations that are customarily considered to constitute consequences of Einstein's relativistic electrodynamics.

In fact, all the fundamental equations of the theory of relativity are derived in a natural and direct way from the equations of electromagnetic retardation, without any postulates, conjectures, or hypotheses. This essentially unites Maxwellian electromagnetics, electromagnetic retardation, and the theory of relativity into a simple, clear, and harmonious theory of electromagnetic phenomena and of mechanical interaction between moving bodies and exposes certain errors in the interpretation and use of Einstein's special relativity. Jefimenko's retarded theory does not use the Lorentz contraction yet yields relativistically correct fields of the charge. He attributes this to the fact that, as a physical phenomenon, the relativistic (kinematic) Lorentz contraction does not exist. It is merely a mathematical transformation between two cartoon worlds as we have shown.

16. Ontological Understanding

There is much confusion about ontology in modern physics; in the case of special relativity theory, this is understandable. Einstein essentially invented an ontology, best described as cartoon worlds, each with its own time dimension and each with an "ether equivalent" that guarantees the same speed of light in every cartoon world. Relative velocity between worlds can be any $\upsilon < c$, but this is meaningless unless there exists a velocity common to all cartoon worlds. By declaring $c =$ constant for all worlds, Einstein made possible the factor $\gamma = \gamma(\upsilon, c)$ that allows one to correlate clocks in cartoon worlds via Lorentz, but he did so in an ontologically confusing way.

> Note that Einstein did not state an axiom to the effect that multiple time dimensions exist; nor did he clearly state this as an assumption! His key assumption is buried in the definition of inertial reference frame, and every problem in special relativity is formulated 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. Einstein assumed the relativity of simultaneity, ostensibly based on his "simultaneity detector" but actually based on his definition of inertial reference frames as possessing separate time dimensions.

Many physicists seem not to think much about ontology; some explain non-intuitive paradoxes as: "our brains did not evolve to understand high-speed." The difference between D^{3+1} or 4D is often viewed as mathematical, rather than as physical reality. McEachern [27] comments:

> "…Planck observed a century ago, the problem is, theoretical physicists are not particularly adept at identifying that some things even are 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."

Energy-time theory predictions differ from space-time theory: based on measurements, they tend to show the multiple time dimensions of cartoon worlds to be idealistic false assumptions. Energy-time theory derives clock slowing of time dilation as an energy aspect of reality, not as evidence of multiple time dimensions. Why then do particle physicists insist upon Lorentz transformation? Lorentz effectively ensures that inertial factor γ governs relativistic mass relations. By building the transformation into the Lagrangian, relativistic mass is properly handled; associated length contraction effects do not come into play. D^{3+1}-ontology physically accounts for relativistic energies without length contraction.

Einstein said of space and time and ether: "There is no such thing as empty space, *i.e.*, a space without a field. Space-time does not claim existence on its own, but only as a structural quality of the field." Laurent Field [28] recently expressed this: "Spacetime is just an abstraction… I believed all my life that spacetime exists, but I no longer do so." Ohanian and Ruffini [29]: "The gravitational field may be regarded as the material medium sought by Newton…". In other words, the gravitational field is the medium through which electromagnetic waves and gravitomagnetic waves travel at the speed of light. As Einstein noted, the gravitational field functions as the ether, a key assumption underlying energy-time theory.

This analysis has focused on ontology, not math, and we have discussed two "ontologies". Ontology is a synonym for reality and there is only one physical reality, hence: two mathematic-based structures can co-exist for quite a while, but only one ontology exists.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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