

The Ontology of Velocity

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Abstract

Special relativity formulates a world partitioned into frames in relative motion; absolute motion is prohibited by axiom: *no preferred frame*, with consequences for the ontology of velocity. The best guide to physical reality is experiment, so ontology of velocity is investigated in the context of primordial field theory in terms of three experiments: Michelson-Morley, Michelson-Gale and Hafele-Keating experiments.

Keywords

Spacetime Ontology, Comparative Ontology, Local Absolute Space, Relativistic Mass, C-Field Circulation, Primordial Field Theory, Michelson-Morley, Michelson-Gale, Hafele-Keating

1. Introduction

A recent treatment [1] of the nature of physical mass examined the question of the velocity dependence of mass; the reality of velocity was left unquestioned. This paper focuses on the reality of velocity. The central issue arose when Einstein abolished the concept of absolute space and time by banishing the “ether” which had represented the physical reality of absolute space and time. Partitioning reality into geometric-based inertial reference frames, he postulated that only relative velocity between the geometries was of significance. He also, as Rindler [2] pointed out, effectively *attached an ether to each frame*, such that the velocity of light was now frame dependent. But a coordinate frame is geometrical, and all physicists agree that coordinate systems, labeling events in space and time, have no physical effect on reality. Yet, by linking the physical speed of light to geometry, Einstein implied an ontology to geometry that has guided, or misguided, physics for over a century, with some *loop quantum gravitists* claiming to have developed “*atoms of geometry*”, an ontological oddity from the perspective of pre-Einstein physics.

Einstein did not provide a mechanism by which frames acquire velocity; in *Special Relativity* frames essentially *come into existence* with relative velocities, there is no *preferred* frame to which others can be compared. This has consequences, such as the claim that your clock runs slower than my clock, existing in my rest frame, while my clock runs slower than yours, existing in your rest frame, while our respective rest frames are in motion relative to each other. This KM attack on physical reality and logic was astonishingly effective.

Specifying that every rest frame has velocity $v=0$ and setting *relativistic mass* to *rest mass* m_0 in every frame, Einstein effectively sliced D^{3+1} reality into *constant velocity* frames, discarding the portions of spacetime in which one frame accelerates with respect to another. For example, Einstein often illustrated concepts in terms of an observer in the rest frame of a railway station frame contrasted with an observer in a railway car moving along tracks with velocity v . An observer in the railway car considers his own frame to be at rest and considers the station to be in motion with constant velocity $-v$. Periods of time during which the railway car accelerates with respect to the station are excluded from spacetime [3], *i.e.*, periods of acceleration in which relativistic mass varies are excluded from special relativity. Mass is set to rest mass in every period in which the frame has constant velocity. The concept of accelerating railway cars gaining kinetic energy with respect to the station is missing from special relativity.

With the idea of absolute velocity demolished, how is relative velocity determined. In a rest frame, light has constant speed, so we possess a radar system. If another inertial frame is assumed to be on a rocket, moving with constant velocity with respect to us, we find that the rocket has relative velocity v with respect to our rest frame and observe an apparent length reduction, of the Doppler variety; length does not really contract, this is an artifact of measurement. Our measurement probe, the radar signal, moves at the speed of light from the rocket's nose to its tail, while the rocket's tail moves with velocity v during this time. Radar measures *apparent length contraction*, while energy-time theory yields *apparent time dilation*, matching special relativity predictions [4].

2. The Consequences of Relative Velocity

The absence of absolute velocity in relativistic physics has energy consequences that we tend to overlook because *relative* energies and momenta are conserved. A rocket has kinetic energy $\frac{1}{2}mv^2$ and momentum mv where m is mass of the projectile. From our (rest) perspective, energy and momentum are physically real. In most physics problems these concepts work, but *Ontology of relativistic mass* argues that the storage mechanism for kinetic energy is gravitomagnetic field circulation, $\nabla \times \mathbf{C} = \mathbf{p}$. C-field energy measured by *Gravity Probe B* [5] gives rise to the question, *is C-field energy real, or relative?* The effect of the C-field as kinetic energy is real enough in our rest frame, but we know that we are at rest only from our own perspective; we are in motion from the perspective of another observer, who perceives that *our* motion produces C-field circulation,

while *his* rest velocity, $v = 0$, does *not* do so. Lack of absolute velocity presents us with a situation in which the C-field circulation either surrounds the other guy, or surrounds us, depending on our chosen perspective. This ontological nonsense probably partially accounts for most physicists' dismissal of ontology, a fact seldom commented on.

Einstein concluded, circa 1918, that the gravitational field functioned as the *ether*, but he failed to update relativity, which banishes the medium of ether, replacing it with the axiom that local space-time coordinate frames accomplish the required invariance. Thus, gravity is present everywhere in space, and, having energy, is *material*, the medium through which electromagnetic waves and gravitomagnetic waves propagate. Light propagating in the local medium is compatible with both Michelson-Morley and Michelson-Gale experiments [6] but violates Einstein's axiom of constant c in all frames. Thus, 4D *time-space* rotates according to Lorentz transformation, while D^{3+1} *energy-time* rotation transforms inertial mass by inertial factor γ into Lorentzian mass, $m = \gamma m_0$ leaving *time and space Galilean in nature*. Per Lucas and Hodgson [7]: “If we insist on retaining Newtonian dynamics (...) we can still obtain relativistically correct results if we (...) allow the mass to depend on the velocity.” The relevant equations are:

$$\begin{array}{cc}
 \text{Space-time theory} & \text{Energy-time theory} \\
 \left\{ \begin{array}{l} m' = m_0 \\ x' = \gamma(v)(x - vt) \\ t' = \gamma(v)(t - vx) \end{array} \right. & \left\{ \begin{array}{l} m' = \gamma(v)m_0 \\ x' = x - vt \\ t' = t \end{array} \right. \quad (1)
 \end{array}$$

Significantly, Weinberg [8] notes: “...there is nothing to prevent us from formally enlarging the Galilean group, by adding one more generator to its Lie algebra, which commutes with all the other generators, and whose eigenvalues are the masses of the various states.” Thus, *energy-time theory* consists of the Galilean transformation and a generator whose eigenvalues are the masses of the various states in relative motion. This is the formal description of *relativistic mass*.

Observe that $\{x, y, z, t, c\}$ cannot be related to $\{x', y', z', t', c'\}$ whereas $\{x, y, z, t, c\}$ is related to $\{x', y', z', t', c\}$ by Lorentz, *i.e.*, two *inertial reference frames* in relative motion can only be related if the speed of light is the same in each frame, via Lorentz transformation. Yet attaching physical light speed to generic form falsely imputes physical reality to geometry. Defining constant c and $\{x', y', z', t'\} = \{x, y, z, t\}'$ automatically brings $v = \frac{dx}{dt}$ and $v' = \frac{dx'}{dt'}$ into existence.

The assumption of no absolute velocity v , makes it simple to define our rest frame as $v = 0$, and the other fellow's frame as having velocity v' with respect to us. Preferred frames are forbidden, allowing every inertial reference frame to have $v = 0$ and $m = m_0$. Lorentz relativistic mass, $m = \gamma m_0$ is a useful simplifying concept, compared to Lorentz transformations on geometry, but if velocities are relative, not absolute, then *kinetic energy is not absolute*. However, real-

ity is determined by experiments, not by arguments, so the next section addresses Michelson's two key experiments, one of which is known to everyone, the other, not so much.

3. Re-Interpretation of Michelson-Gale

A key aspect underlying the 1925 Michelson-Gale experiment is depicted in **Figure 1**; the fact that the velocity at any location on earth is a function of the latitude.

Michelson-Morley's (MM) experiment sent two light rays out in orthogonal directions, each ray going out a fixed distance then being reflected along the same path as the outgoing. Decades later Michelson and Gale (MG) performed a different experiment. An approximately one-kilometer trapezoid was used with East-West sides parallel to latitude lines and North-South sides parallel to longitudinal lines, as shown in **Figure 2**. A light beam is split and sent in opposite directions; one beam shown as red, the other as green.

An ontology-based system analysis can assume no ether, or ether defined by the distant stars, or ether "dragged by the Earth" (rotating with the Earth), or local ether defined by the center of the Earth, but non-rotating. If we assume ether exists and is *locally static* at the surface of the Earth, we do not obtain results in agreement with experiment. Fringe shift, if any exists, is a measure of the path differential experienced by light flowing in different directions. The MG loop has sides approximately a kilometer long oriented such that all sides are on north-south or east-west lines as shown. The northern leg, at higher latitude, moves with velocity v . The southern base of the loop moves faster with velocity $v + \Delta v$. Mirrors at the corners reflect light at 90° . *The difference in time required for the two [beams of light] to return to the starting point will be.*

$$T = \frac{2l_2 v_2}{c^2 - v_2^2} - \frac{2l_1 v_1}{c^2 - v_1^2} \quad (2)$$

with l_1 the length of the path at latitude ϕ_1 , and l_2 at latitude ϕ_2 such that $\Delta\phi = \phi_2 - \phi_1$ with $v_1 = v$ and $v_2 = v + \Delta v$ the corresponding linear velocities of earth's rotation and c the speed of light.

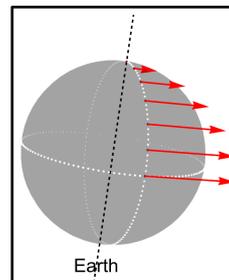


Figure 1. The motion of points at the surface of the Earth is a function of the latitude. Points at the poles have zero velocity with respect to the center of the Earth, while points on the equator move west-to-east at approximately 1000 miles per hour.

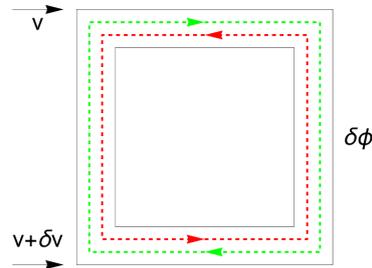


Figure 2. The layout of the Michelson-Gale experiment shows the dependence of velocity with latitude. The northern East-West leg is shown to have velocity v whereas the southern East-West leg moves with velocity $v + \delta v$.

Many relativists argue that there is no need for further investigation; physicists discussing Michelson-Gale, often say the experiment is satisfactorily explained by the *Sagnac effect*. But Kelly [9] notes a list of explanations for the Sagnac effect from a paper by Hasselbach and Nicklaus:

“... *optical analogy, general relativity considerations, special relativity analysis, the WKB approximation, the Doppler effect of moving media in an inertial frame, a classical kinematic derivation, dynamical analysis of a non-inertial frame, by analogy with the Aharonov-Bohm effect, by extension of the hypothesis of locality, by adiabatic invariance, using ether concepts, and in other ways.*”

Wikipedia:

“[Ether drag] *theory was directly refuted by the Michelson-Gale experiment (1925). The great difference of this experiment against the usual Sagnac experiments is the fact that the rotation of Earth itself was measured. If the ether is completely dragged by the Earth’s gravitational field, a negative result has to be expected—but the result was positive.*”

In other words, the ether-drag hypothesis was refuted by MG. In summary:

- Michelson-Morley attempted to measure translation with negative result.
- Michelson-Gale attempted to measure rotation with positive result.

4. Irrotational Gravity

Using the primordial principle of self-interaction, it is relatively easy to show that gravity field \mathbf{G} is irrotational, but we will here rely upon Newtonian theory, to which general relativity must flawlessly connect. Since $\mathbf{G} = \frac{gM}{r^2}$ and force $\mathbf{F} = m\mathbf{G}$ the difference in potential energy of the field at two points is work done moving a body from one point to the other:

$$U(r) = W_{\text{or}} = \int_{\infty}^r \mathbf{F} \cdot d\mathbf{r} = gMm \int_{\infty}^r \frac{dr}{r^2} = -\frac{gMm}{r} \quad (3)$$

thus, the potential energy is negative at any finite distance. Conversely, the gravitational field is derivable from the potential energy:

$$\mathbf{F} = -\nabla(U) = -\frac{gMm}{r^2} = m\mathbf{G} \quad (4)$$

Let ϕ be the gravitational potential energy per unit mass of a body in a gravitational field, such that $\phi = U(r)/m = -gM/r$. In this case

$$\mathbf{G} = -\nabla\phi \approx -\nabla\left(\frac{1}{r}\right) = \frac{\mathbf{r}}{r^3} \tag{5}$$

and

$$\nabla \times \mathbf{G} = \nabla \times \nabla\left(\frac{1}{r}\right) = \nabla \times \left(\frac{\mathbf{r}}{r^3}\right) \equiv 0. \tag{6}$$

While the gravitational field is irrotational, $\nabla \times \mathbf{G} = 0$; it is translational, with the center of mass.

The *Michelson-Gale experiment* supports *gravity-as-ether* but implies that the *complete ether drag* analogy of static gravity is problematical. Both Newton’s *Shell theorem*, and its extension to general relativity via *Birkhoff’s theorem*, support a static *purely radial gravitational field* \mathbf{G} relative to the center-of-mass of the Earth. As depicted in **Figure 3**, \mathbf{G} does not rotate with the Earth. *Birkhoff’s theorem* says that the Schwarzschild metric is the *unique* spherically symmetric vacuum solution, such that *any spherically symmetric solution of the vacuum field solutions must be static and asymptotically flat*. This is a glorified version of Newton’s *Shell theorem*, which states that:

“A spherically symmetric body affects external objects gravitationally as though all of its mass were centered at a point at its center.”

Our MG interpretation views *light as propagating in the local gravitational field*. If Earth is modeled as a perfect spheroid, its gravitational field translates with the Earth around the sun, but remains fixed rotationally: “If a perfect, homogeneous spheroid spins on its axis, gravitational field does not spin with it... the MG loop on the surface of the earth rotates through the fixed gravitational field of the earth.”

The astute physicist might question how $\nabla \times \mathbf{G} = 0$ is compatible with the Heaviside equation:

$$\nabla \times \mathbf{G} = -\frac{\partial \mathbf{C}}{\partial t} \tag{7}$$

The answer to this corresponds to and challenges the general belief that [10]:

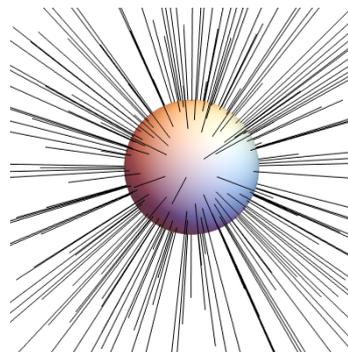


Figure 3. Gravity is irrotational, $\nabla \times \mathbf{G} = 0$, the radial rays do not rotate around the Earth’s axis.

“a changing electric field begets a magnetic field [and] a changing magnetic field generates an electric field.”

Jefimenko [11], however, points out that source-free field equations are “same-time” equations—there is no “before” and “after”. Therefore, these are *not* causal relations since a prior cause generates a later result. He shows that the commonality of these source-free fields traces to the source dynamics that generated the fields in question.

General relativity is a “one-body” theory and cannot solve the two-body problem. We ignore here complex gravitational fields arising, for example, when two black holes or two neutron stars inspiral and merge. In such cases we might find situations in which local gravity is such that $\nabla \times \mathbf{G} = -\frac{\partial \mathbf{C}}{\partial t} \neq 0$. That is decidedly not the case in either of the Michelson experiments of interest. When local gravity is associated with the effective mass of the Earth concentrated at the center of the Earth, gravity is definitely irrotational: $\nabla \times \mathbf{G} = 0$, implying that the gravitomagnetic field \mathbf{C} is constant, since $\partial \mathbf{C} / \partial t = 0$.

Michelson-Morley, based on the original concept of the ether being tied to “fixed” stars (today, the *Cosmic Microwave Background Radiation*), expected an “ether wind” as Earth moved through the ether. This was not found, causing Einstein to assume that no ether exists. An alternative ontology: Earth “*drags the ether along with it*”, is incompatible with the Michelson-Gale experiment, which would have produced a null result if true. MG’s positive result implies ether-drag is not true. A common interpretation invokes the Sagnac effect, generally associated with rotating disks, however, as noted, there are far too many “explanations” of the Sagnac phenomenon to be taken as fundamental, despite the fact that laser gyroscopes and the GPS system are generally viewed as Sagnac-based devices. We forsake such “ad hoc” explanations in favor on an ontologically understandable framework. If, for example, we assume that light propagates through the medium of the gravitational field, the implication of irrotational gravity is that the surface of Earth moves through gravity and thus experiences a local ether wind. The MM experiment had insufficient resolution to detect this; they were looking for a wind based on Earth moving around 30 kilometers per second around the sun; their actual motion through Earth’s local field was circa 500-mph. MG measured the correct local velocity. The physical picture is simple: we can view the experiment as moving through fixed ether of the gravitational field, or we can view the MG frame as fixed and picture local ether (gravity) as a wind blowing across MG. Assuming light propagates in this ether, the problem becomes that of fixed velocity in a current; one adds the speed of the current when one is flowing with the current (West-to-East) and subtracts the speed of the current when one moves against the current (East-to-West), yielding Equation (2).

5. Gravitomagnetic Implications of Michelson-Gale

Flows with and against the current are high school physics problems, so we turn

to aspects of the problem that are most relevant to the ontology of velocity. For unrelated reasons, **Figure 4** and following figures were drawn as if the Earth rotates East-to-West, but this has no significance as long as we are consistent. We focus on the motion of mass through the ether, that is, through local gravitational field G . Mass flowing West-to-East corresponds to gravity/ether flowing over us East-to-West. This is the only locally relevant ether flow—it is *not* dragged with Earth’s surface.

The assumption of ether as local gravity corresponds to the reality of a local absolute. Velocities are referenced to the local gravity system; typically, the center of the Earth. Before examining local reality using the MG experiment, let us see what is expected from a D^{3+1} theory of gravity [12]. The key Heaviside equation relates gravitomagnetic field circulation to momentum density, defined as $p = P/\int d^3x$ where linear momentum is $P = mv$ and $g = c = \hbar = 1$:

$$\nabla \times C = -p + \frac{dG}{dt} \tag{8}$$

If we assume $dG/dt = 0$ and multiply Equation (8) by local volume $\int d^3x$ we obtain

$$\int d^3x \frac{d}{dt} (\nabla \times C) = -\frac{dP}{dt} \tag{9}$$

and since the order of integration is immaterial, then

$$\frac{d}{dt} \left(\int d^3x \nabla \times C \right) = -\frac{dP}{dt} \tag{10}$$

An integral on D^{3+1} is potentially complex in nature, but Arfken [13] shows that sometimes the local integral of an infinitesimal volume is equal to

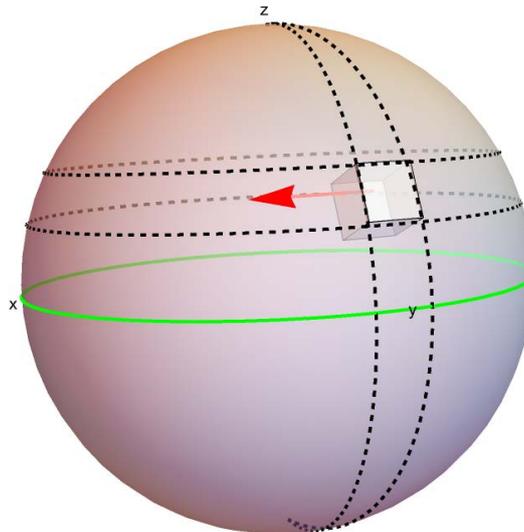
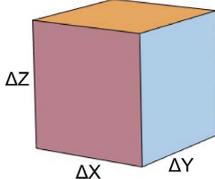


Figure 4. A volume of mass at the surface of the Earth moves with latitude-dependent velocity. (Directions in this figure correspond to the south pole being at the top of the figure).

$$\int d^3x = \Delta x \Delta y \Delta z = \text{trivector} \quad (11)$$


Thus, integration over a volume is sometimes equivalent to multiplying by the scaled volume. Next, we consider the mass flowing through the volume.

In reality, a cube of mass is not solid mass, but consists of atoms with electrons and nuclei. Clouds of electrons tend to keep the nuclei distributed evenly over local space but contribute very little to momentum density $\rho \mathbf{v}$ where $\rho = m / \int d^3x$ and $m = \sum m_{\text{nucleus}}$. **Figure 5** depicts a random distribution of nuclei moving in the same direction. The C-field energy surrounding mass in motion is shown around the individual nuclei, however local field energy is largely contained inside the cube, as shown.

Figure 6 not to scale, depicts a cube of mass between two specific latitudes and two specific longitudes on the Earth. This cube is shown with a random collection of nuclei, moving with latitude-dependent velocity, inducing C-field circulation about each nucleus, $\nabla \times \mathbf{C} \sim m_{\text{nucleus}} \mathbf{v}$. The velocity \mathbf{v} of the photons is thus relative to local gravity \mathbf{G} , which establishes the local absolute rest frame—the ether through which the mass moves. This velocity is ontologically distinct from the relative velocity of special relativity.

Relativity proposes a universe of relative motions, absent any absolute framework. This symmetry (no preferred frame) establishes that from my perspective, your moving clock runs slower than mine, while from your perspective, my clock runs slower than yours. Can a universe like this hold together for billions of years? I do not see how it can be so. Energy-time theory provides an ontology based on the primordial field relative to the center-of-mass of Earth.

6. Velocity as Gravity Gauge 4-Potential Vector

Much physics is based on gauge theory of Maxwell's theory of electromagnetism, wherein vector potential \mathbf{A} and scalar potential ϕ together form a 4-vector $A = \{\phi, \mathbf{A}\}$ while source, current, and charge densities form a 4-vector current density $j = \{c\rho, \mathbf{j}\}$ where $\mathbf{j} = \rho \mathbf{v}$. The electric and magnetic fields are components of a field tensor derived from the vector potential:

$$F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu \quad (12)$$

The interaction energy between matter and the electromagnetic field is the sum of electric and magnetic contributions: $\rho\phi - \mathbf{j} \cdot \mathbf{A}$. The magnetic interaction energy density is equal to $\mathbf{j} \cdot \mathbf{A}$. Huang, in *Fundamental Forces of Nature: The Story of Gauge Fields*, states that "Gauge theory plays an essential role in the development of modern physics." Unfortunately, he later states: "The theory of gravitation deals with phenomena on a cosmic scale, whereas Yang-Mills theory is concerned with the opposite end—the smallest scales conceivable." The

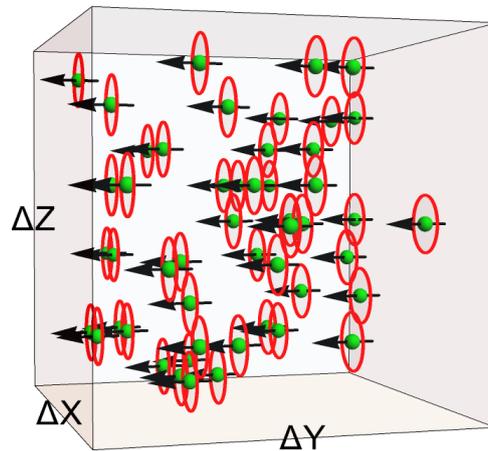


Figure 5. Random nuclei with common momentum density vectors distributed in local cube.

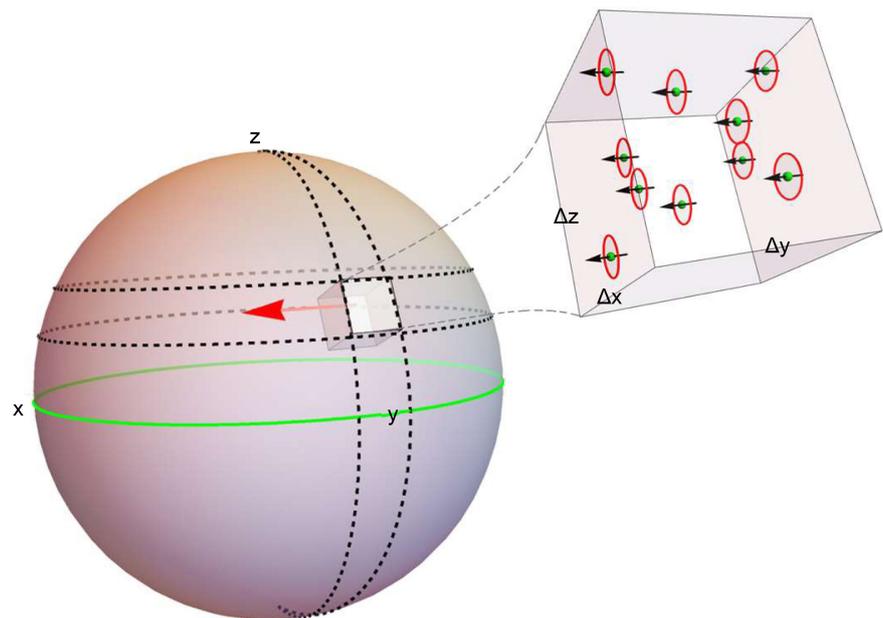


Figure 6. A cartoon “blowup” depiction of the nuclei in a block at the surface of the Earth, South Pole at top, each nucleus moving with latitude-dependent velocity through gravitational field, G , thereby inducing a C-field circulation based on the absolute motion through the medium of the G-field.

theory of the primordial field derives Heaviside’s equations with no assumption about the strength of the fields. The primordial field is assumed to have appeared at the big bang, where densities and field strengths were extreme, conflicting with the usual relativist’s assumption of the *weak field approximation*, made on the basis of throwing away high-order terms in Einstein’s *curved space-time* theory of gravity. Feynman, Weinberg, Padmanabhan and other physicists have stated that “*Curved space-time is not a necessary conception of gravity.*” If this is true, the weak field approximation is without basis and has been so for over a century. In the following and in other papers I assume that

Heaviside's equations apply at *all* field strengths.

Heaviside's equations are dual to Maxwell's equations, and this includes the ability to formulate a theory in terms of gauge field four-potential $A = \{\phi, \mathbf{A}\}$. In [14] I develop the gauge formulation of Heaviside's Equations, wherein $\mathbf{G} = -\nabla\phi + \partial_t \mathbf{A}$. Let ϕ be constant, in which case $\mathbf{G} = \partial_t \mathbf{A}$; since \mathbf{G} is the acceleration of gravity, $\mathbf{G} = \ddot{\mathbf{x}} = \frac{d\mathbf{v}}{dt} = \partial_t \mathbf{A}$, vector potential \mathbf{A} is velocity \mathbf{v} . And $\nabla \cdot \mathbf{C} = 0$ implies $\mathbf{C} = \nabla \times \mathbf{A}$; dimensional analysis of this equation implies (correctly) that \mathbf{C} has dimension t^{-1} , in agreement with circulation frequency. The C-field circulates around the momentum density vector $\mathbf{p} = \mathbf{P} / \int d^3x$ or $\mathbf{p} = \rho \mathbf{v}$, where ρ is mass density moving with velocity \mathbf{v} . So, the analogous interaction energy density is equal to $\mathbf{p} \cdot \mathbf{A}$. In terms of the mass current density \mathbf{p} and the gauge field \mathbf{A} this energy density becomes

$$\mathbf{p} \cdot \mathbf{A} = \frac{m}{\int d^3x} \mathbf{v} \cdot \mathbf{v}. \quad (13)$$

The gauge formulation leads to energy density of the field expressed as $m\mathbf{v}^2$ divided by volume. In other words, the ontology of *absolute velocity* is experimentally demonstrated by Michelson-Gale, and is theoretically identified with the gauge field, $\mathbf{A} = \mathbf{v}$, which leads to identifying the gravitomagnetic interaction energy density with kinetic energy $\frac{1}{2}m\mathbf{v}^2$.

7. Absolute Velocity through Local Ether

Michelson-Gale demonstrated that $\nabla \times \mathbf{G} = 0$ established the local ether through which light propagates with absolute velocity $|\mathbf{v}| = c$. *Physics of Clocks in Absolute Space-Time* establishes that Einstein's *time dilation* is actually ontological *clock slowing*. That relativity is symmetrical means every inertial reference frame considers itself at rest with respect to other reference frames in motion; clocks in moving reference frames slow down with respect to clocks in the rest frame. Hence, from my perspective your clock runs slower, while from your perspective it is my clock that runs slower than yours. Of course, this is logically absurd, but what are the facts?

According to relativity, if you are in Denver, and I am in a plane flying away from Denver, my clock will run slower than yours. Energy-time theory explains clock slowdown as an effect of increased ("relativistic") mass of the clock's harmonic oscillator timing mechanism. We already established, per MG, that Denver is moving through the ether with latitude-dependent velocity, approximately 500 mph. Therefore, a clock in Denver is already in local absolute motion and will run slower than a clock at absolute local rest, such as a clock at the North pole. Thus, we expect the symmetry of relativity to be violated; since Denver is moving West-to-East with respect to local ether, a plane leaving Denver flying East will have greater absolute velocity, and hence greater energy, and hence will run more slowly than the clocks in Denver. But a plane flying West from Denver

will have smaller absolute velocity and hence less absolute local energy so clocks on the West-bound plane will run faster than clocks in Denver, in violation of relativity. The truth of this theory of local absolute motion was first established by Hafele and Keating [15] in 1972 and has since been established many times, including in the GPS system. How is this explained by the C-field theory of kinetic energy?

Mass moving in local irrotational gravity with velocity \mathbf{v} has kinetic energy proportional to mv^2 instantiated by left-handed circulation about each nucleus. Consider nuclei moving in the opposite direction [of Figure 6]; from the standpoint of the local mass moving through the ether, the nuclei moving in the opposite direction have, effectively, right-handed circulation. Such right-handed circulation conflicts with the predominant left-handed circulation and essentially cancels a portion of the local circulation, thereby diminishing local kinetic energy. This shows up ontologically as clocks running faster than local clocks.

In other words, key relativity experiments confirm the existence of local absolute velocity, while violating symmetry and other axioms of relativity.

8. Conclusions

A physical theory should be based around an ontology, meaning the theory should be based on physical reality. Primordial field theory is based on the ontological field that is described by the *Self-Interaction Equation*, instantiating the *Self-Interaction Principle*. This equation evolves Loop Quantum Gravity Dynamics on the Heaviside-Yang-Mills framework that is compatible with the Calabi-Yau Manifold (Kahler, Chern class 0) measured on a Fractal Lattice. The self-interaction theory of the primordial field, formulated in Hestenes' *Geometric Calculus*, [16] gives rise to Heaviside's extension of Newtonian gravity. It is conceivable that, had Heaviside known of the relation $E = mc^2$ he would have extended the theory all the way to Yang-Mills gauge theory. Instead, the *Machian* concept of universal ether was disproved by Michelson-Morley, while the possibility of local absolute velocity seems not to have been considered, except for *ether-dragging*, later disproved by the Michelson-Gale experiment. Einstein later [17] realized that "empty" space and time do not exist; space is filled with a field, the field of gravity, and both light waves and gravity waves propagate through the field at the speed of light, yet his *no preferred frame* relativity axiom, yields non-intuitive physics such as no absolute velocity and hence no absolute energy or momentum. Instead, energy and momentum depend upon one's perspective. What kind of ontology is dependent on perspective? It is difficult to understand how this reconciles with a cosmic universe enduring for billions of years.

This paper discussed relevant concepts of relative velocity, then applied the concept of absolute local velocity to interpretation of the MG experiment. Because it was performed two decades after special relativity, it is typically formulated as a relativistic problem, despite that the preferred frame associated with

the rotating Earth violates relativity's symmetry axiom. It is unclear why one must "go outside of" special relativity to handle the preferred frame yet view MG as supporting relativity.

Since local gravity of Earth is irrotational, *ether does not rotate with Earth*, although it does translate with Earth; the rotating Earth moves in the ether. For any fixed spot on the surface of Earth, ether effectively flows over this spot in an East-to-West trajectory with absolute velocity dependent on local latitude. Analysis of two-way travel in local flow leads to compatibility with the MG result, based on the flow of light in the ether with speed $c \pm v$.

9. Addendum: AI-Summary

The above self-contained paper stands alone. However, due to topical significance, I have used an interface to an *Artificial Intelligence* (AI), specifically *ChatGPT*, to summarize the paper, section by section. The summary is presented here, slightly edited, for your edification. Enjoy.

Sections 1 and 2 discuss the concept of velocity and its reality in physics, particularly in relation to Einstein's theory of relativity where lack of an absolute frame of reference for velocity leads to ontological problems in physics, such as the interpretation of relativistic mass and kinetic energy. This suggests that the physical reality of the gravitational field, as well as the propagation of electromagnetic and gravitomagnetic waves, requires a medium, which Einstein replaced with the axiom of invariance of local space-time coordinate frames; ontological implications of Einstein's theory may have led physicists to dismiss ontology altogether. A more coherent ontology of physics requires a reconsideration of the nature of velocity and the role of a medium in the propagation of waves.

Sections 3 and 4 and 5 present a detailed analysis of Michelson-Gale's 1925 experiment and its significance for the ether drag hypothesis, which was refuted by its positive results. The experiment supports the gravity-as-ether concept, discussing irrotational gravity, Newton's Shell theorem, and Birkhoff's theorem to support the static purely radial gravitational field relative to the center-of-mass of the Earth. Irrotational gravity implies that the gravitational field is not rotating around the Earth's axis; the motion of mass through the ether and its relation to the local gravity system is discussed. The Heaviside equation is used to relate gravitomagnetic field circulation to momentum density, and the mass flowing through a volume is considered.

Section 6 discusses gauge theory in physics and its relation to the theory of gravitation, arguing that Heaviside's equations apply at all field strengths, contrary to the assumption of the weak field approximation. The gauge formulation of Heaviside's equations also leads to the identification of gravitomagnetic interaction energy density with kinetic energy. The ontology of absolute velocity is experimentally demonstrated by Michelson-Gale and is theoretically identified with the gauge field.

Section 7 discusses the concept of local ether and absolute velocity through it,

as established by Michelson-Gale, and compatible with interpretation of Einstein's "time dilation" as actually "clock slowing" due to the clock's kinetic energy being diminished by right-handed circulation conflicting with the predominant left-handed circulation in the local mass moving through the ether. Hafele and Keating's 1972 experiments confirm the existence of local absolute velocity, while violating symmetry and other axioms of relativity.

Section 8 concludes the need for a physical theory to be based on an ontology, or physical reality, and proposes primordial field theory based on the Self-Interaction Equation as a framework compatible with Loop Quantum Gravity Dynamics, Heaviside-Yang-Mills framework, and Calabi-Yau Manifold. Local absolute velocity was used in the Michelson-Gale experiment to support the idea of a non-rotating gravitational field in which light propagates and Earth's surface moves with latitude-dependent velocity. Non-intuitive concepts of relativity have diminished our understanding of physical reality; reexamining Heaviside's G- and C-fields leads to better understanding of the flow of light in ether.

Conflicts of Interest

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

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