

Beyond Relativity to Flowing Space

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Abstract

Relativity and Quantum Theory were designed to limit physics to describing the observer's observations and measurements. They assumed that space is nothing, a void with no physical qualities. However, the evidence indicates that "empty" space is a substance, and as such may be the causal nexus of all fundamental physical phenomena. Physics can be reconstructed upon a theory of the nature of Cosmic space and its role in all phenomena. We now know enough about gravity and inertia to make a start. The simplest explanation for the accelerational effects of gravity is that space is the seat of inertia, and that in a gravitational field inertial space is accelerating radially towards the center of mass, causing test masses to accelerate with it. A flow will also have a velocity. The predicted velocity of this inflowing space at any given height is identical to the escape velocity from that height. This velocity field correctly models the electromagnetic effects of gravity including the gravitational redshift and black holes. Thus a physical interpretation of Einstein's equivalence of gravitational and inertial acceleration exposes a new equivalence of gravitational and inertial velocity. This theory provides a single causal mechanism for the transverse redshift in motion and in gravity and unites gravity and inertia as two aspects a single physical process. It reproduces the successful equations of General Relativity with greater simplicity and makes additional predictions that can be tested. It suggests causal explanations for many hitherto unexplained phenomena. It is a program for a new physics that deals with the nature of the Cosmos and the causes of all phenomena.

Key words: atomism, ether, gravity, inertia, Mach's principle, principle of equivalence, Relativity, space, strong force, transverse Doppler shift

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1. The Need for a New Program for Theoretical Physics

Scientists seek to understand the nature of the Cosmos and of the causes of all its phenomena. However, they are using models which were specifically created to avoid this task. With his 1905 papers on Special Relativity and the lightquantum, Albert Einstein imposed a radical philosophical program on physics. It was based upon the idealistic metaphysics and subjectivistic epistemology of Berkeley, Hume, Kant and Mach.[1] This program was Positivism and it held that humans should not try to theorize about the nature and causes of things, but should only describe what is evident to their senses and instruments. Positivism gave us Special Relativity (SR), General Relativity (GR) and Quantum Theory (QT). These are quantitative models that describe and predict the observers' experiences and measurements. They are not physical theories per se—they begin with no assumptions about the nature of space or matter and they do not try to explain the unseen causes of phenomena. Scientists today do not realize that these models are not appropriate to their goal of understanding physical reality. Therein lies the confusion.

Relativity attempted to relate all phenomena to any observer's frame or arbitrary coordinate system; not to the space and matter of the Cosmos. This was a reversion to anthropocentrism—to the epistemology of the Ptolemaic system which had described the motion of the planets and stars in the Earth-observer's frame. Einstein understood this; he claimed that Relativity made the historic struggle between the views of Ptolemy and Copernicus “meaningless” since it was only a matter of one's choice of coordinate system.[2] Asserting that all motion was merely “relative”, Einstein dismissed the ether (the idea that space had physical qualities) as “superfluous”. [3] His absolute c , time dilation, space-time, mass-energy, and lightquantum were never physical hypotheses, they were instead “freely created” concepts for the limited purpose of “finding regulative connections between our sensual experiences.”[4] SR and GR treated Cosmic space and evolution (time) as mere measurements—the readings given by the observer's rods and clocks. Einstein knew that the space-time interval had no physical significance,[5] yet scientists today speak of space-time to be the “fabric” of the Cosmos and its distortion the “cause” of gravity. They are inappropriately reifying the observer's measurement concepts—as if they were physical entities and causes. They are using Relativity for a purpose for which it was not designed.

When he formulated General Relativity (GR), Einstein realized that rotation, inertia, and gravity could not be fully “relativized” because they were uniquely related to the local frame that was itself conditioned by the nearby and distant distribution of matter. He conceded that space itself had physical qualities, therefore was an ether.[6] Einstein thus contradicted both the metaphysics and epistemology of the Relativity program. However, he did not recognize or resolve this contradiction. In fact he admitted that in the field of epistemology he was an “unscrupulous opportunist”, resorting to realism, idealism, positivism, and Platonism as the situation seemed to require.[7] Natural philosophy requires consistency. Relativity survives to this day because it “works” just like the Ptolemaic Cosmology did—it gives the right answers in most situations when applied in the right way—and because no one has yet succeeded, as did Copernicus, to replace it with an observer-independent, Cosmic theory of what is really moving, relative to what, and why.

2. The Undeniable Physicality of Space

When we go beyond merely describing Cosmic phenomena and attempt to understand the nature of the Cosmos and the causes of physical phenomena, we immediately encounter the question of space. Is “empty” Cosmic space nothing or it is something? Is it not-A or A? Is it a void or a substance? There is no middle ground; there are no other possibilities—either it has physical qualities or it does not. We must choose between two mutually exclusive hypotheses:

atomism: Space is nothing, a void. It has no physical qualities and neither causes nor interacts with any phenomenon. Gravity, electromagnetism, and all other Cosmic phenomena are produced by interactions of various self-existent particles.

etherism: Space has physical qualities and is a substance. It is the physical substrate of all Cosmic phenomena. Gravity, electromagnetism, and all known particles are different kinds of motions of or distortions within this substance.

Is atomism a tenable hypothesis? If space is a void, if it is literally no-thing, then we are left with no possible way to explain fundamental physical phenomena. We cannot even address questions like what causes light’s velocity to be fixed and independent of its source’s velocity. Why doesn’t light move by ballistic principles? Relative to what in this Cosmos does light actually move at c and why? How is it possible for light to exist as a wave if there is no

substance that can support waves (by deforming and restoring)? How can there be a field in space if there is no substrate that is altered? If space is a void, what is preventing atoms and subatomic particles from moving at c or faster? What causes the spectra of moving atoms to be red-shifted? A void would pose no resistance to acceleration or velocity, so any object should be able to move at infinite velocity with no resistance; yet we know this is not the case. If space is a void, what resists the acceleration of matter? Why can't the slightest "kick" accelerate any mass to infinite velocity? If space is a void, why are some "frames" inertial and others not? Why is rotation "absolute"? Relative to what? If space were a void, none of these physical phenomena could exist, let alone have any possible physical explanation. Indeed, in Relativity and Quantum Theory these phenomena are simply taken for granted, as if they exist by magic.

Physicists, adhering to the atomism inherent in Relativity and Quantum Theory, yet seeking to understand the causes of phenomena, have filled empty space with various hypothetical substances: quantum foam, vacuum energy, Higgs field, curled-up dimensions, membranes, dark energy, dark matter, strings, etc.. Is a void-space that is packed-full of unseen and undetectable particles or fields any different from an ethereal space? If we posit a void full of unseen particles, we will still require a theory of space to explain why those particles move as they do, why they then have mass-inertia, etc.. It is more economical to instead assume that space itself is a substance, and to attempt to build a new physics upon that foundation.

3. Static vs. Flowing Space

The logical starting point for linking a new theory of space to existing models is to replace Special Relativity with the Lorentz Ether Theory. They are known to be equivalent for descriptive and predictive purposes. Lorentz's electromagnetic ether in which light propagates at c and within which moving atoms' spectra are redshifted and moving rods shortened due to their velocity is perfectly consistent with the known phenomena and does not produce SR's paradoxes. Lorentz's Ether Theory was an electromagnetic elaboration of Newton's mechanical "absolute space". Newton posited a uniform, immobile, Euclidean, pan-Cosmic ether that resisted the acceleration of bodies but was not itself affected by matter. Einstein concluded that this one-way causal interaction was implausible. He favored Ernst Mach's proposal that inertia was due to an interaction of the test mass with all other masses in the Cosmos. Since Einstein

rejected instantaneous action-at-a-distance, he concluded that Mach's principle led back to the ether, which served as the medium for the inertial interaction. In 1920, Einstein stated,

“Mach's ether not only conditions the behavior of inert masses, but is also conditioned in its state by them...Mach's idea finds its full development in the ether of the general theory of relativity.

What is fundamentally new in the ether of the general theory of relativity as opposed to the ether of Lorentz consists in this, that the state of the former is at every place determined by the connections with the matter and the state of the ether in neighboring places, ...”[8]

However, since the existence of an ethereal space contradicted the Relativity program, Einstein could not proceed to model ether-space itself. Instead he produced a mathematical model of its effects on the observer and his measurements. He ended his University of Leyden lecture with a statement that underscored his dilemma:

“According to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an ether... But this ether may not be thought of as endowed with the quality characteristic of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it.[9]

He admitted that space was a substance, but forbade anyone to theorize about its nature or its interaction with matter! However, if space is indeed a substance, then it must be the primary focus of theoretical physics. We must violate Einstein's prohibition and use his insights and our current knowledge to construct a theory of Cosmic space and motion.

4. The Equivalence of Gravitational and Inertial Acceleration

Isaac Newton had speculated that gravity was caused by a flow of space into celestial bodies. He discussed this theory in letters to Oldenburg, Halley, and Boyle.[10] He declined to pursue this idea in the *Principia*, famously declaring “*hypotheses non fingo*”. He instead posited the existence of a single uniform, immobile “absolute space” in which matter could move without resistance at any uniform velocity, but which resisted matter's acceleration. He asserted that all

matter had some definite velocity in absolute space, even if it could not be determined.[11] Newton did not succeed in explaining gravity; he simply added it as an occult attractive force acting within absolute space.

Einstein improved upon Newton's theory by modeling what falling and accelerating observers would experience. He realized that being held stationary in a gravitational field (as on Earth's surface) had similar effects on one's sensations and measurements as being accelerated in deep space by a rocket (at 9.8 m/s^2). He concluded, as Galileo had discovered centuries earlier, that gravity was an accelerational field, not a force. Thus he formulated his principle of the equivalence of gravitational and inertial acceleration (EGIA).

We can relate Einstein's EGIA to physical space with a simple, reasonable conjecture: The accelerating space ship and the Earth-surface observer feel the same effects because the cause is the same—both are in a state of acceleration relative to their surrounding space. Being physically restrained by the structure of the ship and the Earth's surface, neither is free to return to the natural state of non-acceleration relative to space. Their "frames" are not inertial. An inertial frame can now be defined as one that is not accelerating relative to its local surrounding inertial space, i.e. it is accelerating with the acceleration of its surrounding space. An observer in free fall in a gravitational field is in a state of uniform, non-accelerating motion within a space that is itself accelerating towards the gravitational mass (planet, star, etc.). An inertial space that accelerates radially towards the center of Earth at GM/r^2 explains the known ballistic-mechanical aspects of gravity.

Using Einstein's EGIA, we have improved upon Newton's theory of space—transforming his absolute spatial solid that is not affected by matter into a fluid that is forced to flow into matter as into a sink. We have thus eliminated the need for an *ad hoc* gravitational force. Can this simple hypothesis explain other effects of gravity such as the gravitational red-shift of atomic spectra and the existence black holes? If so, can it be mere coincidence?

5. The Equivalence of Gravitational and Inertial Velocity

If inertial space is a substance that flows into Earth and all matter as a fluid into a sink, then it must have not only an acceleration at any given distance, but also a determinate velocity. Its velocity at Earth's surface ought to be the sum of its total acceleration from rest at infinite distance to Earth's surface, as revealed by the motion of a test mass released at infinite distance

and falling towards the Earth. This velocity has been calculated by various methods and is identical to Newton's escape velocity—the initial velocity that allows any object near a large mass to escape the mass's entire accelerational field. Therefore the velocity of inflowing space at any radius r , outside any mass, M , should be:

$$v_{space} = \sqrt{2GM/r} \quad (1)$$

(Interestingly, the equations of spatial acceleration and velocity indicate that space is not an ideal fluid but is compressible and/or deformable. See **Appendix A**) If, as ether theory suggests, a moving atom's spectrum is red-shifted by its physical interaction with electromagnetic space, then an atomic clock held stationary at any given height in a gravitational field should be affected by the velocity of the inflowing space and should slow according to the Lorentz transformations just as if it were moving in deep space at that velocity. This is indeed the case. The experimentally-confirmed formula for the gravitational slowing of atomic clocks is:

$$\Delta f/f = 1 - \sqrt{1 - 2GM/rc^2} \quad (2)$$

Since $v^2 = 2GM/r$, then by substitution we find that the gravitational red-shift formula is identical to that for the transverse Doppler shift produced by velocity:

$$\Delta f/f = 1 - \sqrt{1 - v^2/c^2} \quad (3)$$

Thus the predicted velocity of space at any given height in a gravitational field correctly predicts the slowing of atomic clocks at that height. The predicted inflow velocity at Earth's surface is 11.2km/s , and we know that atomic clocks on or near the Earth's surface slow just as if they were moving at this velocity. If a clock is placed higher above Earth, it experiences a lower inflow velocity and runs faster. It has the lowest spatial velocity and runs at the fastest rate when in deep space and at rest relative to the nearby distribution of matter—when it is nearly at rest in physical space.

We have thus derived the formula for the gravitational red-shift from the simplest possible explanation of gravity, and produced a physical link between the ballistic and electromagnetic effects of gravity. The former is due to the acceleration of space, the latter to its velocity. Both the Lorentz transformations (of SR), and the EGIA (of GR) are hereby related to an objective matter-influenced Cosmic space instead of to arbitrary observers and coordinate systems. (See Fig.1) We have unified transverse Doppler redshifting by velocity and by gravity—the slowing

of an atomic clock now has only one cause in all circumstances; its velocity in physical space. (See **Appendix B** for a proposed mechanism.) We have thus exposed a new principle of equivalence of gravitational and inertial velocity (EGIV). This principle was not exposed by, and cannot be explained within Relativity. (**Appendix C**) Combining the two equivalence principles yields the equivalence of gravitational and inertial acceleration and velocity (EGIAV). This principle reflects our finding that a body's acceleration and velocity relative to its surrounding space produce their respective physical effects regardless of the cause of the relative motion.

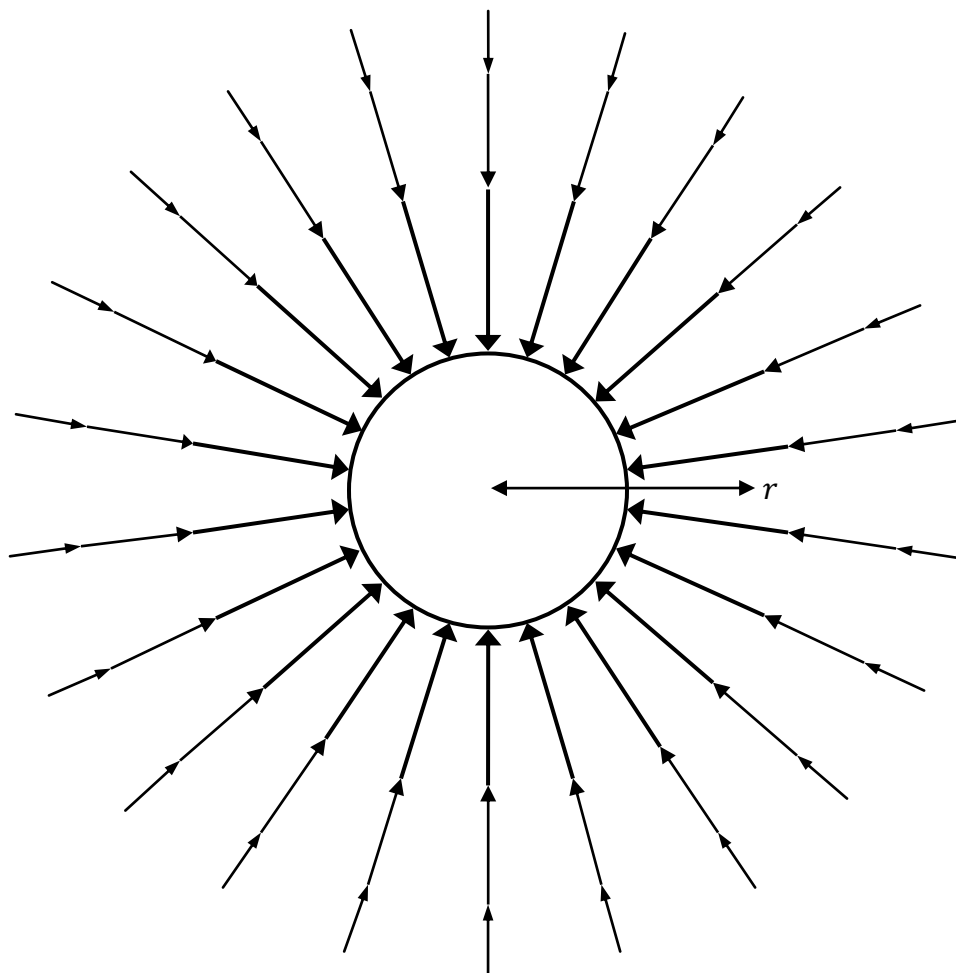


Figure 1. Two-dimensional representation of the gravitational flow of electromagnetic-inertial space towards the surface of a celestial body. The velocity of the flow at any height, r , is $\sqrt{2GM/r}$ and its acceleration is GM/r^2 . This flow explains both the ballistic and electromagnetic effects of gravity.

Can this theory reproduce the other successful predictions of General Relativity with equal or greater simplicity? Herbert Ives and Robert Kirkwood published several papers on the flowing space hypothesis between 1939 and 1954. Ives demonstrated that if an object in a gravitational field were affected as if it had the escape velocity for that height—if its frequency were redshifted, if it were shortened in the vertical direction, and if its effective mass were increased—then the successful predictions of GR were produced with greater simplicity, including gravitational lensing, the gravitational redshift, and the advance of Mercury’s perihelion.[12,13] Whereas Ives considered these effects to occur within an isotropic Newtonian-Lorentzian space, Kirkwood presented a similar mathematical treatment of a physical space that actually flowed into all matter.[14,15] Recently, Tom Martin demonstrated that, for an isolated gravitational attractor, a Galilean frame with a spatial inflow or outflow of speed $\mathbf{w} = \sqrt{2GM/r}\hat{e}$ gives all of the correct General Relativistic physical effects usually associated with the static and curved space-time Schwarzschild solution.[16]

Consider the simplicity with which this theory predicts and explains the existence of black holes. If the spatial flow velocity into the surface of a massive body is $\geq c$, and if as expected, light is a wave that propagates through this physical space at c , then light cannot escape the body. The Schwarzschild radius[17], R_S , is produced in this theory by simply solving the escape velocity formula (1) for r , and setting the spatial inflow velocity equal to c :

$$R_S = 2GM/c^2. \quad (4)$$

This derivation is far simpler than Schwarzschild’s, follows from a simple physical hypothesis, and produces predictions not found in Relativity (see below). It does not require four-dimensional space-time. It implies no mathematical singularities, nor loss of information, nor wormholes, nor other universes; only a conglomeration of matter so massive and compact that light cannot propagate out through the space that is flowing inward at $\geq c$. The more massive and compact the black hole, the greater the spatial inflow velocity at its surface. The validity of this flowing space model of black holes has recently been recognized as the “river model” of black holes; in which space flows into a black hole through a flat background and objects move within the flowing space according to the rules of SR.[18] The theory presented here applies this same model to weak gravity situations such as we have here on Earth, and considers the model to be a true representation of the underlying physical reality.

6. Ethereal Mechanisms

Etherism is an entirely different program for physics. It requires that we interpret all phenomena as due to cause-effect motions in/of ethereal space. It allows us to theorize about the causes of fundamental physical phenomena. It forces us to no longer speak of abstract “forces” or “energy” but in every case try to determine the ethereal mechanism involved. For instance, rather than consider length as a mere measurement, we will be aware that it is always the product of some number of ethereal-spatial units. Space must have smallest parts of some determinate size, the ultimate quantum, in order to produce the uniformity that we observe. Perhaps it is composed of “cells” at the Planck length (10^{-33} cm). Time likewise is not just a measurement, nor a dimension, but is the procession of ethereal cause and effect. We describe and measure this causal evolution by comparing any process to that of a clock—which is itself some regularly-recurring cause-effect process (atomic frequencies, crystalline vibrations, Earth’s orbit, pulsars etc.). Mass and energy are just different kinds of motion in/of ethereal space, which accounts for their interconvertibility. The known particles are not self-existent, but are instead persistent patterns of organized motion in/of the ether. Light is a transverse wave in the electromagnetic-gravitoinertial ether. Electromagnetic fields must be altered states of the ether, perhaps involving a distortion, rotation, or internal rearrangement of the ether’s cells. Electrons are persistent electromagnetic wave structures. Gravity waves are low-frequency longitudinal-hydrodynamic compression waves in the ether. These are just some of the ways in which ether theory requires a reassessment and redefinition of all the fundamental concepts in physics.

Several generations of physicists have been taught a number of anti-ether arguments, all of which capitalize on inadequacies in older ether theories. Some of the arguments are based on simple misconceptions, and none in any way proves that space is not a substance. For instance it is said that space should have an extreme rigidity in order to transmit light at c , and this is incompatible with the passage of matter through space without resistance at subluminal velocities. This is a *non sequitur* because space can indeed have extreme electromagnetic rigidity yet flow around moving matter without resistance. Electromagnetic and hydrodynamic motions are qualitatively different phenomena, there is no contradiction in holding that space can respond differently to each.

How do we go about characterizing this unique substance? We simply have to ascribe to it all the qualities needed to explain the phenomena, no matter how strange they may seem. What we cannot do, of course, is produce theories that contain contradictions or that are contradicted by known facts. This task requires imagination, for space is certainly unlike the ponderable matter with which we are familiar; matter is the product of ethereal mechanisms. Mass must be the result of some sort of motion of or distortion within a space that is itself without mass.

6.1. Flowing Space's LT Dimensional System

This physical interpretation of gravity leads to a new and fruitful interpretation of our dimensions and the gravitational constant, G , and provides a quantitative and qualitative model of inertial mass. Having characterized gravity as due to the acceleration and flow of a massless space, we can reduce our mass unit (kg) to a function of length (L) and time (T). James Clerk Maxwell suggested[19] that if mass were defined in terms of the acceleration it produced, its units would be $L^3 T^{-2}$. This is apparent from the Newtonian formula: $GM = ar^2$, which requires that GM have the units $L^3 T^{-2}$. In order to emphasize the spherical geometry of spatial flow, we reinsert the canceled 4π terms to produce:

$$4\pi GM = a4\pi r^2 \quad (5)$$

In hydrodynamics, the strength of a sink is given by $4\pi S = v4\pi r^2$ with units $L^3 T^{-1}$, representing the uniform volume flow rate of an ideal fluid through any concentric spherical surface outside the sink. We can similarly interpret Newton's $4\pi GM$ as describing matter's sink strength—the centripetal spatial acceleration (LT^{-2}) that it produces through any given spherical area ($4\pi r^2$) outside the mass M and sharing its center. Thus mass appears to be a radially-symmetrical accelerational field within massless space. $4\pi G$ with units $m^3/kg s^2$ is just the conversion factor between kilograms and LT units. For instance, the sink strength, $4\pi GM$, of a $1kg$ mass is $8.4 \times 10^{-10} m^3/s^2$, while that of the Earth is $5 \times 10^{15} m^3/s^2$. The larger/stronger is the inflow field, the greater its interaction with the surrounding space, the greater its mass, its inertia, and its gravity. In LT units, momentum (Mv) has units $L^4 T^{-3}$, force (Ma) is $L^4 T^{-4}$, and energy (Mv^2) is $L^5 T^{-4}$.

To treat the electromagnetic effects of gravity, we consider that matter produces a spatial velocity which affects atomic clocks and light outside any mass. $4\pi GM$ describes the product of the square of space's velocity ($L^2 T^{-2}$) and the circumference ($2\pi r$) at any r :

$$4\pi GM = v^2 2\pi r. \quad (6)$$

It may prove useful to include EM phenomena in this unified LT system. We can again follow Maxwell, substituting $L^3 T^{-2}$ for M in his MLT electromagnetic units.[20] Electrostatic charge will have units $L^3 T^{-2}$ (identical to mass); the electrostatic field appears as an acceleration, LT^{-2} . EM charge has units $L^2 T$; EM voltage is $L^2 T^{-2}$, etc. The EM permittivity of free space, μ , has units $L^{-2} T^2$, and the permeability of free space, ϵ , has no units ($L^0 T^0$).

6.2. Inertia from Gravitation

We have shown how the evidence implies that gravity is a field of spatial sink flow. It is known that gravitational and inertial mass are equivalent.[21,22] This theory provides a plausible explanation for this equivalence: the dynamic, accelerative field of flow that matter creates in its surrounding space not only causes other matter to accelerate towards it (gravity), but also tethers the body in space so that any translational acceleration of the body relative to its larger surrounding space is resisted (inertia). Gravitation is the cause of inertia. Gravitational and inertial mass are equivalent because they are two aspects of the same physical process.

Why would space resist the acceleration of matter? If all matter is indeed an energetic field of sink flow within the ether, then when any mass ($L^3 T^{-2}$), is forced to accelerate (LT^{-2}) relative to the surrounding space, the opposing accelerations within massless space would create pressure or tension that would resist the acceleration of the mass. For instance, on the anti-directional side of the mass, the mass is forced to accelerate away from the very space that it is accelerating towards itself ($L^4 T^{-4}$). These opposing accelerations would produce tension if the spatial units or cells cannot move instantaneously, at infinite velocity, into the region to relieve the tension. Once the force is no longer being applied to the mass, the tension due to opposing accelerations in space is eliminated, and the mass can move at a uniform velocity in the massless, frictionless space with no resistance ($L^4 T^{-3}$). Thus a mass's inertia—the resistance space offers to its acceleration relative to space—is best explained as the result of the mass's gravity—the accelerational field it creates in space.

The gravitational “force” between any two comparable sinks in relatively close proximity is described by the Newtonian equation:

$$F = 4\pi G(M_1M_2)/4\pi r^2 \quad (7)$$

This is just the multiplication of the two sink strengths. In this theory, this force is actually a description of the tension ($L^3 T^{-2} \times L^3 T^{-2} = L^6 T^{-4}$) that exists in the intervening space between two sinks when they are prevented from accelerating towards one another.

6.3. Gravito-Inertial Flow and the Hadronic Strong Force

What could cause ethereal space to flow into matter? It is probable that not all forms of motion (mass-energy) create gravity. We have, in fact, measured gravity and seen true inertial motion only in hadrons, atoms, and multiatomic masses. Electrons have never been shown to create gravity and their movement in space is not gravito-inertial in character. There is also no evidence to support the supposition that light, electromagnetic fields, pressure, momentum, heat, or any other forms of motion create gravity. It is therefore reasonable to presume gravity is a unique physical process associated with hadrons. The spatial inflow may be an aspect of the unique hadronic “strong interaction” that binds quarks together in hadrons and hadrons together in the nucleus. This strange perpetual force may be maintained by the consumption of space, causing the surrounding space to flow continuously toward all hadrons.

This physical model of gravity and the strong force may shed light on hitherto unexplained phenomena. We know that there is excess heat production in the cores of all planets and there is an abundance of iron in the Earth’s core. If hadronic/nuclear stability depends upon this consumption of space, which must enter the planet from outside, then deep within the cores of planets there will a relative ether deficit and high spatial tensions which could destabilize nuclei, causing excess fission or fusion. This instability could produce excess heat and an abundance of iron and nickel, the most stable nuclei with the highest binding energies per nucleon. The same tension may occur on astronomical scales. When a number of large spatial sinks are in close proximity, such as the stars in a galaxy or globular cluster, there will be an increased ether tension as space must flow into the region from outside to reduce the tension. This increased spatial tension among the sinks would appear as an excess of gravitational attraction, currently interpreted as due to undetected “dark” matter.

6.4. The Entrainment of Space by Matter

If indeed matter is a spatial sink, how does it affect the motion of the surrounding space as it moves through it? We would expect that a large, powerful sink, like Earth, would create in its massless, nearly frictionless surrounding space a proportionally large extended field of co-moving radially-symmetrical sink flow, probably to a distance of many radii. The extent of this co-moving, symmetrical flow-field would depend upon the mass (greater) and the velocity in space (smaller). It would be made smaller in extent also by interactions with the flow fields of nearby celestial bodies.

If Earth did not create a uniform radial flow field in its surrounding space, then its orbital motion would cause a spatial wind on its surface. Space would flow at 30km/s through and around the Earth. This is the “ether wind” posited by the opponents of Copernicus, and sought by Michelson and Morley. Flowing space instead provides a causal mechanism for the space-drag or entrainment first propounded by Stokes[23] to explain the null Michelson-Morley experiment. Indeed, the data from all sources, including our extensive experience with satellites and our global positioning system, indicates that Earth completely determines the motion of its surrounding inflowing space for a very great distance. Its gravity pulls the surrounding space into motion with Earth in its 30km/s uniform motion through the larger volume of space that is entrained by and flowing into our Sun. Thus the Earth appears to be stationary relative to its surrounding space. An artificial satellite in orbit about the Earth is moving tangentially through the Earth-centered, radially-oriented field of sink flow. The satellite’s atomic clock is slowed in a consistent manner by its tangential velocity in Earth’s entrained, co-moving gravitational flow-field. It is not exposed to the 40km/s centripetal Solar gravitational flow at Earth’s distance, nor is it affected by the $\pm 30\text{km/s}$ velocity it has relative to the Sun at various points in its orbit about Earth. What about small masses, what is the size of their entrainment fields? The fact that an atomic clock in a satellite or airplane does experience the ether wind due to its velocity in space, causing the transverse Doppler effect, indicates that the mass of these vehicles is far too small to entrain space collectively as does a planet. Their constituent nuclei must entrain space only to a sub-atomic distance, allowing the outer electronic shells to be exposed to the translational ether flow.

While Earth sweeps its surrounding space into its inertial motion about the Sun, it clearly does not sweep space into its own rotation to any significant degree, nor could it given the theory of gravity and inertia here presented. There is irrefutable evidence of several kinds that the inflowing space is not significantly dragged into rotation with Earth: the Coriolis effect, the rotation of the Foucault pendulum, the Cosmic-directional stability of gyroscopes, and the Michelson-Gale experiment.[24,25] Therefore, relative to an Earth-surface observer, light travels at $c - v_{rot}$ in the easterly direction, and at $c + v_{rot}$ in the westerly direction. Experiments have revealed that light signals do travel at different velocities around Earth in opposite directions,[26] and atomic clocks slow at different rates traveling east vs. west along Earth's surface.[27] These facts are consistent with the Earth rotating within its entrained inflowing ether field, producing a rotational spatial wind of $465m/s$ at Earth's equator that diminishes to zero at the poles.

Because of this entrainment of its surrounding space, Earth appears to our instruments to be stationary but rotating, while it and its surrounding field of sink flow are moving uniformly at $30km/s$ within the much larger sink flow-field that is accelerating towards our Sun. Our Solar system's entrained flow-field is moving within the space entrained by nearby and distant stars in the Milky Way, and the Milky Way and its own entrained space are moving within the space entrained by the surrounding galaxies. Entrainment thus provides a model for how all the matter in the Cosmos influences both the Cosmic and the local inertial and luminiferous "frame". Entrainment fulfills Mach's Principle, and is actually assumed in applications of General Relativity though not explicitly acknowledged as such (see below). A physical space whose state of motion is determined by the local distribution of matter "breaks the symmetry" between any two frames' merely relative motion. It is because of entrainment that all motion is most simply treated in the frame of the nearby celestial mass or masses. It is because of entrainment that the twin who remains at rest relative to the nearby celestial body(ies) has a lesser spatial velocity and faster clock than the twin who is in motion relative to same.

Some have argued that Earth cannot be entraining its surrounding space as this would eliminate stellar aberration for the Earth observer. Such arguments, like other anti-ether arguments, are based on some particular theory of the ether and the relevant phenomena and can be answered by an appropriate alteration of the theory. In fact, when aberration is considered, it is Relativity that is inconsistent with the facts. (**Appendix D**)

The explicit acknowledgment of entrainment suggests a possible solution to the galaxial rotation anomaly that does not require dark matter. Each of the stars in a galaxy's disc entrains a very large volume of surrounding space into its revolutionary motion about the galaxial center. If the extent of entrainment by each star is great enough, then the stars collectively will drag much of the space within the galaxial disc into rotation about the galaxial center. The inertial "frame" of the entire galaxy would be dragged into rotation to various degrees at various distances from the center, giving the galaxy its vortical appearance. As the entire galaxial spatial frame is rotating in the direction of the stars' motion, the outer stars need to maintain their orbital velocity within that frame to avoid falling towards the galaxial center. So they will appear to have a higher orbital velocity relative to the external, non-rotating frame or the surrounding galaxies.

7. Testing Flowing Space

Relativity is a description of measured effects in the observer's frame. It is not a competitor to this or to any other objective, physical theory of Cosmic phenomena. Flowing Space is a working objective model of space and motion encompassing the entire Cosmos. It is both rich in predictions and falsifiable.

7.1. Testing Flowing Space vs. Static Space (-time) Models

Flowing Space makes many predictions not found in any *static*-space model, such as the Newton-Lorentz ether model. It also predicts phenomena that are not found in Einstein's static four-dimensional space-time curvature. Consider the implications of spatial flow into or out of matter:

1. Light rising away from Earth's surface, against the Earthward spatial flow, will move at $c - 11.2km/s$ relative to Earth's surface. Light falling downwards towards Earth will move at $c + 11.2km/s$. All celestial bodies should produce a corresponding differential velocity. Light velocity is difficult to measure locally due to the well-known problem of synchronizing clocks using the very signal whose velocity one is trying to determine. For instance, in this theory, the GPS clocks are all offset to compensate for the up/down light velocity anisotropy. It may be possible, however, to detect light velocity anisotropy in gravity in other ways.

2. The spectra of atoms falling towards or moving upwards away from Earth's surface at a given velocity relative to Earth should be redshifted to different degrees. The falling atoms are moving with the flow of space and will have a smaller spatial velocity and redshift, while rising atoms are moving against the flow of space and will have a higher spatial velocity and redshift. Likewise muons rising against the spatial inflow at near- c relative to Earth will persist longer than muons falling with the same Earth-frame. An atomic clock falling in Earth's gravity should run faster than one rising away from the Earth at a similar velocity. The Vessot-Levine rocket experiment[28] involved an atomic clock rising and falling in Earth's gravity, but it was complex in design and based on Relativistic assumptions. It could not distinguish between Relativity's static-curved space-time, with no up-down anisotropy, and flowing space.[29] It would be a simple matter to devise similar experiments with involving atomic spectra or atomic clocks that could differentiate static-space theories from flowing space.

3. In flowing space, matter may be observed falling into celestial bodies at velocities greater than c (relative to the gravitator). In the case of a black hole, the velocity could exceed $2c$. Tom Martin has demonstrated that spatial sources could produce gravitational acceleration and velocity effects similar to those of spatial sinks,[30] so astronomical observations may also detect light or matter moving away from spatial sources at velocities $\geq c$. Relativity and static-space theories exclude velocities $>$ or $< c$ in any given frame.

4. This theory with its Earth-entrained space does not require the Fitzgerald length contraction to explain the null Michelson-Morley experiment. If the length contraction is not a physical reality in all circumstances, then an interferometer rotated from a horizontal to a vertical position on Earth's surface could detect a fringe-shift consistent with the gravitational 11.2km/s spatial wind. However the deformation of any such device by gravitational acceleration is probably an insurmountable problem. Without the Lorentz-Fitzgerald contraction, an interferometer orbiting Earth could produce a fringe-shift consistent with its velocity in Earth-entrained space.

5. At the boundary between the spatial flows of two bodies there will be anomalous atomic clock-slowness and accelerational effects. These could be detected by observing the motion and atomic-clock rate of a satellite which passes through the boundary. Such tests could distinguish between the usual static curved space-time solution of Schwarzschild and this General-

Relativistically-valid flowing space solution in the region of the gravitational saddle point of the Sun and Earth and at other parts of the boundary between the solar and terrestrial flows.[31,32]

7.2. Testing Entrainment vs. Non-Entrainment of Space

Entrainment not only explains the phenomena without paradoxes, it also provides additional tests to distinguish this theory from theories without entrainment. Relativity cannot overtly include entrainment since it treats all motion as only relative to any chosen coordinate system. With the entrainment of space by all large celestial bodies, the relative slowing of atomic clocks or atomic spectra on the bodies' surfaces will be predicted by their individual spatial inflow velocities only; there will be no transverse Doppler due to the two celestial bodies' relative motion, as would occur with small masses moving in space. Disregarding the small rotational velocities, spectra emitted by identical sources on the surfaces of the Sun and Earth should have periods differing only by the different velocity of the local inflows:

$$(v_{Sun}^2 - v_{Earth}^2)/c^2 = 4.24 \times 10^{-6}, \quad (8)$$

where v is the spatial flow velocity at the surface. This is indeed what the data show[33] and, surprisingly, how the data are treated in textbooks.[34,35]

However, this treatment is incompatible with Relativity. Relativity, and physical theories without entrainment, must predict a larger Earth-clock red-shift, and therefore a smaller difference between the periods of the two clocks than does an entrained-space theory. In Relativity, the Earth and Sun spectral comparison should reflect not only the local gravitational redshift on each body, but also the additional slowing due to the transverse Doppler caused by their 30km/s relative motion. Relativity would also have to include the redshifting of the Earth-surface spectra/clocks by the Sun's own gravitational redshift at Earth's distance, a 43km/s spatial wind. The Earth's gravitational redshift at the Sun's surface can be ignored as it is only a 0.05km/s spatial wind. So a full non-entrainment Relativistic treatment, where ϕ is the gravitational potential, GM/r , with units m^2/s^2 , corresponding to $\frac{1}{2}v^2$ would predict that an Earth observer would see the Sun clock slowed by:

$$[2\phi_{Sun} - (2\phi_{Earth} + 2\phi_{Sun@Earth}) + v_{Sun-rt-Earth}^2]/c^2 = 4.22 \times 10^{-6} \quad (9)$$

Unfortunately, this is only a small difference and the rising and falling of emitters on the Sun's surface makes the Sun's spectral red-shift too difficult to determine with sufficient accuracy. However, the principle described above may be testable in other situations, such as observing spectra on other planets or with atomic clocks on probes in orbit about other planets. To support entrainment, one need only find that the relative velocity of the star, planet, or galaxy and Earth does *not* produce a transverse Doppler redshifting of their atoms' spectra as would be predicted without entrainment.

8. Conclusion

The concept of a flowing space place physics on an entirely new foundation. It is firmly grounded in the successful insights of Newton and Einstein and the evidence as it exists. It explains the known macro-phenomena in the simplest possible manner and produces no paradoxes. It produces remarkable simplifications; providing a single mechanism to explain the transverse redshift of spectra by velocity and by gravity, and a single mechanism to explain gravity and inertia. It provides a mechanism for Mach's principle. It produces the successful predictions of General Relativity with greater simplicity, and makes predictions that can be tested. It leads to promising conjectures about the causes of hitherto unexplained phenomena.

Flowing Space restores the ether and physical causality to physics. It reopens the book of Nature that has been closed for more than one hundred years. As it relates macrocosmic phenomena to an ether with microscopic parts, it can permit an integration of our ideas about both realms. The substance of space may have many of the characteristics postulated for strings and membranes in current Quantum Mechanical theories. Flowing space does present many difficulties and raise many questions, but so must any theory that takes that first step beyond mere description and attempts to explain the nature of the Cosmos and the causes of all physical phenomena. Even though some aspects of this theory prove incorrect, we must not again default to merely modeling our measurements. We must alter this theory of space as the evidence dictates, or produce a better theory of space and motion. We must persist in our efforts to model the Cosmos and to explain the causes of all its phenomena. The result will be a philosophical revolution no less profound than those begun by Copernicus and Darwin, a revolution that allow us to produce new technologies, preserve our biosphere, and travel to the stars.

Appendix A: The Gravitational Deformation of Space

The ether's inflow velocity is proportional to $\sqrt{1/r}$, whereas an ideal fluid's velocity approaching a sink is proportional to $1/r^2$, its volume flow rate being identical at any given distance. So the apparent velocity of space as it approaches matter increases more slowly than expected for an ideal fluid, indicating a progressive loss of volume of the individual ether cells, a loss of cells in the flow, or a lengthening of the individual units of space (called "spaghettification" in discussions of black holes). Modeling this non-ideal behavior is challenging for the distances we measure with rods or light signals are themselves affected by any alterations in the size and shape of the ether's spatial elements. Only a Euclidean, extra-Cosmic observer who was not affected by variations in ether cell size could measure the "true" distances and accurately characterize the ether cells' size and shape at every location. For instance, an EM disturbance probably moves from ether cell-to-cell at the same rate, regardless of the size or shape of the cells. So the Euclidean observer may "see" light moving faster where cells were longer and slower where they were shorter, while we could not appreciate this effect. It is possible that this variation in cell size could produce lensing effects under certain circumstances. Space will likely prove to be both stranger and simpler than we can imagine.

Appendix B: An Ethereal Mechanism for the Transverse Doppler Redshift

Relativity holds that this "time-delay" redshift is only apparent, a matter of perspective, while ether theory holds that the redshift is real, caused by the physical interaction of the moving atom with its surrounding space. It is not hard to imagine a mechanism for the Doppler redshifting of spectra due to velocity in space. If electrons are composed of circulating EM waves that propagate through the ether at c , then when an atom is in motion in space, the waves of its outer electrons are forced to propagate through a greater ether-distance in their journey around the nucleus. Their oscillatory frequency will be slowed. The greater distance traveled in the ether is described by the Pythagorean theorem, which is the basis of the Lorentz transformations and yields the correct transverse Doppler redshift. The electron oscillating around a moving nucleus is the physical analogue of the "bouncing light clock" described in introductions to Relativistic theory.

Appendix C: Relativity and the Equivalence of Gravitational and Inertial Velocity

Can Relativists “explain” the equivalence of gravitational and inertial and velocity (EGIV) within their own system, without the flowing space hypothesis? They cannot. A prominent Relativist dismissed the evidence for this equivalence as a fortuitous coincidence;[36] against which assertion the theory here presented is sufficient argument. A previous reviewer claimed that the EGIV is merely a consequence of the observer-based equivalence of gravitational and inertial acceleration (EGIA) and does not require the flowing space hypothesis. He argued that an observer falling toward Earth from an infinite distance (in *vacuo*) would accelerate to a velocity of 11.2km/s at Earth’s surface; and thus to him a clock on Earth’s surface would appear slowed when he passed by it. This is the Relativistic program: evade the physical reality of space by placing an observer in a given “frame” and modeling what that observer will measure. I will show that this observer-based rationalization does not follow from Einstein’s EGIA, contradicts SR, and exposes the ambiguity of Relativity. The EGIV has not been noticed or seriously discussed until this time precisely because it cannot be understood within Relativity. Consider that:

1. Relativists must assert that the physical effect of the mass of Earth on the rate of an atomic clock is “explained” by inventing an observer, letting him fall towards Earth, and speculating on what he would “see”. On the contrary, atomic clock-slowness on Earth’s surface is, in fact, evident to the Earth-surface observer, even though he is not in free-fall and has no velocity relative to the clock. He can put a clock on a high tower for some time, bring it back down, and see that it ran faster than his Earth-surface clock; even though both clocks were at rest relative to himself throughout the test. This fact demonstrates the objective and physical nature of this effect and exposes the artificiality of trying to “explain” gravitational clock-slowness using falling observers.

2. We know that inertial acceleration does not slow atomic clocks, whereas gravity and velocity do. The EGIA alone thus cannot explain gravitational clock-slowness. The only link that Einstein made between SR, acceleration, and velocity in his presentations of GR was his thought experiment involving the slowing of clocks due to their velocity on the periphery of a rotating disc,[37] and this has no relevance to the relationship between gravity and velocity discussed here. Since any velocity can be associated with any acceleration, the association of this particular velocity with this free-fall observer in gravity requires an additional assumption, free fall from

infinity, that stipulates the velocity and thus violates the strong version of the EGIA. Flowing space predicts this velocity on the basis of a physical model of gravity.

3. Relativists apply the Lorentz transformations to this particular free-falling observer's velocity to explain the slowing of the clocks. But SR, the subjectivistic (observer/frame-based) interpretation of the Lorentz transformations, does not provide the needed velocity assumption. SR does not treat gravity or acceleration and thus did not predict and cannot explain why gravity produces this apparent velocity. To invoke SR here is to violate the equivalence principle of SR: the doctrine that SR is valid in every freely falling frame, no matter what it's velocity. One would need to admit, instead, that in the real Cosmos where gravitation is present everywhere, SR is actually valid only in the frames that fall from all points at infinity towards the center of the gravitational mass, constituting a radial array that resembles a field of flow, whose velocity at every point outside a mass equals the escape velocity. One must, in essence, reproduce the flowing space theory. This unique frame array is neither consistent with the assumptions of Relativity, nor does it follow from them. It is yet another ad hoc modification of Relativity to make it fit the facts.

The EGIV that was predicted and explained by this theory cannot be explained within Relativity by appeal to observers using the EGIA and/or SR. Einstein predicted the escape velocity formula for the gravitational red-shift using by giving unique importance to the one observer falling from infinity, thus violating the principle of Relativity. Atomic clock-slowness by gravity is a physical reality that must be related to space itself, as it is affected by nearby mass.

Appendix D: Aberration, Flowing Space, and Relativity

In Relativity, aberration must result from the relative motion of source and observer. Stark's experiment refutes this claim—the direction of light arriving from stationary and high-velocity moving atoms at the same location was identical.[38] The data from the aberration of individual stars in a binary system is also refutes Relativity. The stars' aberrations do not vary with the stars' velocities relative to Earth, i.e. when they are moving with or against Earth's motion. [39, 40] These data instead support the theory that light is propagating through a physical medium. In such a space, aberration is produced only by the observer's velocity in the luminiferous medium; not by the source's velocity in the medium. The source's velocity would produce only a light travel-time-delay displacement of its apparent location. Specifically, in this gravity-entrained ether theory, annual stellar aberration is caused by Earth and its entrained space's orbital motion

within the larger region of space entrained by the Sun and surrounding stars. The fact that the Earth-surface observer is not moving in his surrounding (Earth-entrained) space does not eliminate aberration. The entrained space that he is in is itself in motion at 30km/s relative to the Sun-star space. Light propagating from the Sun-Star space into the moving Earth-entrained space will aberrate in the gradual transition zone between the Sun-Star frame and the moving Earth's entrained ether flow. The discussion of ether, entrainment and aberration is complex and would need to be resurrected. Stokes, Lorentz, and Planck addressed this issue at end of the 19th century. Lorentz concluded that aberration was consistent with an Earth-entrained ether if the ether were condensed in gravity and if light maintained the same velocity in both non-compressed and compressed ether.[41] The theory here presented appears to satisfy these criteria, but more research and modeling will be required.

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