Beyond Newton and Einstein to flowing space

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(Received 29 January 2012; accepted 5 August 2012; published online 19 October 2012)

Abstract: In order to explain the physical nature of motion and of gravity and their effects, we must ascribe physical qualities to cosmic space. Space is a substance, the seat of gravity, inertia, electromagnetism, and particle formation. The author asserts that space has many of the qualities imputed to it by Newton, Maxwell, and Lorentz, but that gravity and inertia are caused by matter's consumption of space. Space appears to be a massless, frictionless quantized fluid. It accelerates as it flows centripetally into all matter at GM/r^2, explaining gravity's ballistic effects. Its velocity at any given height is $\sqrt{2GM/r}$, explaining gravity's electromagnetic (relativistic) effects, including the gravitational redshift and black holes. This flow of gravitoinertial-electromagnetic space is the physical reality underlying the successes of Newtonian mechanics and general relativity. The theory is philosophically superior to existing models; it explains, simplifies, and unifies the phenomena and makes additional predictions. [DOI: 10.4006/0836-1398-25.4.500]

Résumé: Afin d'expliquer la nature physique du mouvement et de la gravité et leurs effets, nous devons attribuer qualités physiques à l'espace cosmique. L'espace est une substance: le siège de la gravité, l'inertie, l'électromagnétisme, et la formation des particules. L'auteur affirme que l'espace a beaucoup des qualités attribué par Newton, Maxwell, et Lorentz, mais que la gravité et l'inertie sont causées par le flux réel de l'espace. L'espace semble être un fluide quantique sans masse ou friction. Il accélère comme il s'écoule centripètement dans toute matière à GM/r^2, en expliquant des effets balistiques de la gravité. Sa vélocité à chaque hauteur est $\sqrt{2GM/r}$, en expliquant des effets électromagnétiques (relativistes) de la gravité y compris le décalage vers le rouge gravitationnel et les trous noirs. Ce flux de l'espace gravitationnel-inertiel-électromagnétique est la réalité physique qui sous-tendent les succès de la Mécanique Newtonienne et la Relativité Générale. La théorie est philosophiquement supérieure aux modèles existants; elle explique, simplifie, et unifie des nombreux phénomènes; et fait des prédictions supplémentaires.

Key words: Atomic Clocks; Black Holes; Ether; Gravity; Inertia; Matter; Principle of Equivalence; Relativity; Space; Space-Time; Time Dilation; Transverse Doppler Redshift.

I. INTRODUCTION

There is a simple physical theory of gravity that logically explains and mathematically models both its ballistic (Galilean–Newtonian) and relativistic (Lorentzian–Einsteinian) effects. I shall call it the flowing space theory. It has appeared in peer-reviewed journals in various forms since the early 1920s. It has never been disproved; it has simply been ignored. I believe that the reasons for its obscurity are several: the belief that the current mixture of Newtonian mechanics, classical electrodynamics, relativity, and quantum mechanics works just fine and need not be superseded; the prohibition of ether theory; and the absence to date of a comprehensive philosophical and physical argument in support of the theory. This paper will address each of these issues and show that this theory of spatial flow is more than just a useful analogy; it is the key to unlocking a new physics of space.

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II. SPACE IS A SUBSTANCE

The cosmos is a highly complex, coherent physical system. Every effect we observe must have a physical cause, whether it is apparent to our senses or instruments or not. To discover these causes, we can create and test theories about what exists and produces the effects we observe. This effort has been traditionally known as natural philosophy. There is another way of doing physics, of which relativity and quantum mechanics (QM) are examples. These models attempt only to describe and predict the observers' measurements and observations—the contents of consciousness.[1] They were created in the heyday of positivism in order to avoid any theorizing about what exists and causes the observed phenomena, to avoid metaphysics. They substituted the observer's ideas—his information and mathematical formulae—for cosmic theory. Lacking any physical explanation for a phenomenon, the observer's ideas have become the cause. Their central concepts (e.g., space-time, photon, energy, dimensions, entropy) are observer-based,

observer-invented measurement and prediction devices; they do not represent any cosmic objects or causes. They are epistemologically equivalent to the equants, epicycles, and deferents of the observer-based Ptolemaic system. Consider that space-time is likewise composed of observers' measurements; the intervals, $ds^2 = c^2dt^2 - (dx^2 + dy^2 + dz^2)$, that they measure between events, using their rods and clocks.

To highlight the contrast between these two ways of doing physics, consider some of the fundamental questions of physics:

(1) What resists the acceleration of matter, causing its inertia, yet allows it to move at constant subluminal velocity without resistance, but prevents it from moving at c?
(2) Why does light always move at c, regardless of the velocity of its source? Relative to what is it physically moving at c?
(3) What causes the transverse Doppler redshift of the spectra of moving atoms (time dilation)? Relative to what are they physically moving?
(4) What causes the similar redshift of spectra in a gravitational field? Is it a different mechanism?
(5) What causes the accelerational and velocitylike (relativistic) effects of gravity?

Note that relativity and QM do not attempt to answer these questions. They simply incorporate the phenomena into laws—regularities in the observers' experiences. They relate the phenomena to the observer or arbitrary frames, not to space itself. They therefore imply that cosmic space is nothing, a void. However, if space were a void, then none of these phenomena can be explained; they could not even exist. In a void, every location and every movement is indistinguishable, equally devoid of any physical meaning or effect. A void could not resist or affect the motion of anything within it—neither the acceleration nor the velocity of matter or of light. In a void, matter could move at infinite velocity in any frame. In a void, rotation would have no physical effects. In a void, the rate of atomic clocks could not be slowed by motion. There could be no electromagnetic waves or fields, for there is no medium to be altered. In short, if space were a void, nothing could be the way that it is. If we, on the other hand, decide to do more than find laws that correlate and predict our experiences and measurements; if we attempt find answers to these questions, we must ascribe physical qualities to space itself.

I submit that most physicists do not believe or even understand the esoteric observer-based ideology that Einstein learned from Ernst Mach and David Hume; that was created by Bishop Berkeley.[2] Most physicists and cosmologists want to know the causes of cosmic phenomena. Since relativity and QM prevent them from thinking of space as a substance, when they do theorize about causes, they resort to atomism. They populate the void with hypothetical self-existing particles (e.g., photons, virtual particles, strings, Higgs bosons, neutrinos, neutralinos, tachyons). This approach multiplies hypotheses beyond necessity. A void is a mathematical abstraction, like the dimensionless point or infinity. It corresponds to nothing real, to nothing we experience in this cosmos. The space we know has the properties of a substance. Therefore, it is neither necessary nor efficient to posit the existence of a hypothetical void and also of many hypothetical, self-existing particles in the void. In addition, atomism has a problem; if the hypothetical particles' motions have any regular qualities of a relational nature (e.g. invariant velocity, inertia, limiting velocity), then in order to explain these qualities, one must again attribute physical qualities to space.

Grasping the deficiencies of atomism, others fill the void with various hypothetical space-filling, etherlike entities: quantum fluctuations, quantum foam, vacuum energy, $Q\bar{Q}$ condensate, Higgs field, curled-up dimensions, membranes, dark energy, and even other universes. These are *ad hoc* fixes for a deficient theory of space and matter. It is more logical to admit that space is a substance and see what the facts tell us about it.

Both Newton and Einstein realized that the facts required space to be a substance. Newton's absolute space was a single, Euclidian, pancosmic substance that resisted the acceleration of matter. He asserted that all matter had some definite velocity in absolute space, even it could not be determined.[3] Einstein admitted that general relativity endowed space with physical qualities, that there was an ether.[4] Recently, Nobel laureates Laughlin[5] and Wilczek[6] have also asserted that the facts require space to be a substance. Wilczek has gone further, calling space "the grid. . . the primary ingredient of physical reality, from which all else is formed".[7] However, he tries to describe space using relativity and QM, which were created to evade the reality of space and its role in physical processes. These models are inappropriate for the study of space. If space is a substance, we need a new physics.

III. SPACE MOVES

How do we begin to theorize about cosmic space and its role in all phenomena? A sensible starting point is the pre-Einsteinian consensus among the world's greatest physicists that space is the seat of both gravitoinertial phenomena and of electromagnetism. Let us reconsider the Newton–Maxwell–Lorentz theory of space and modify it as required by the insights and knowledge we have gained in the last 100 years.

A. Newton's theory of space and motion

What is it that resists matter's acceleration but not its uniform velocity? Relativity and QM provide no answer. They cannot explain inertia because it is necessarily relational—an interaction between matter and something else, some frame. Unless we are willing to resort to magic, this frame must interact with matter locally, by contact. The simplest theory is that this frame is space itself. The etherlike Higgs field was invented to save the standard

model by giving particles their mass; however, it does not explain inertia or gravity—the defining qualities of mass.

Newton did try to explain cosmic phenomena, but his absolute space was an abstract idea—an undeveloped hypothesis. For instance, it affected matter's motion but was not affected by matter in any way. Such a one-way interaction was impossible by Newton's own third law of motion; it was a reaction without an action. So we ask, what is matter doing to space that would cause space to resist its acceleration?

Let us consider the logic and implications of Newton's laws of motion. With space as the seat of inertia, resisting matter's acceleration relative to itself, matter's natural motion in space is nonaccelerated uniform motion (uniform velocity). To make matter accelerate relative to its surrounding space requires a force—a push or pull. The application of force elicits matter's inertia—its weight ($F = ma$). It exposes the existence of a dynamic interaction between matter and space. Likewise, an observer in space, absent any force, remains in freefall—a state of nonacceleration relative to his surrounding space. If he is forced to accelerate relative to space, he feels this acceleration as weight, and his accelerometer measures the effect.

Now what if cosmic space were not absolute, not an inert pancosmic solid, but were instead dynamic—a fluid that accelerated as it flowed in certain regions of the cosmos? What would happen to matter or an observer if the surrounding space were accelerating in some direction? I submit to you that, since matter cannot naturally accelerate relative to space and since there is no applied force and/or any other frame to affect matter's motion, matter must passively accelerate with its surrounding space, and this acceleration will not elicit weight. An observer in freefall in an accelerating spatial field would accelerate with space's acceleration. Since he would not be in a state of acceleration relative to space, he would feel no weight, and his accelerometer would measure zero.

If a mass were at rest in space initially and that region of space began to accelerate up to a given velocity, the mass would accelerate with space up to that velocity. It would remain at rest in space. If a mass had an initial uniform velocity in space and then moved through a region of spatial flow and acceleration, the mass would accelerate or decelerate with the spatial flow's acceleration. It would not be affected by the flow's velocity. The change in the mass's velocity would be proportional to the time spent in the accelerational field. Therefore, we can begin to transition from Newtonian physics to space physics with this definition: the acceleration (dv/dt) of any mass in freefall reveals the acceleration of space in that region.

B. Spatial acceleration and Einstein's principle of equivalence

Can the idea of a Newtonian inertial space that can flow help to explain gravity? Newton actually speculated that gravity was caused by a flow of space into celestial bodies. He discussed this theory in letters to Oldenburg, Halley, and Boyle.[8] However, he declined to pursue this idea in the *Principia*, famously declaring *hypotheses non fingo*. In order to develop his theory, he required knowledge that we have gained only in the last 100 years. So he instead resorted to magic. He added gravitation as an instantaneous action at a distance, an attractive force with no possible mechanism. It was an expedient with which even he was never satisfied.

Einstein, seeing the inadequacy of Newton's theory of space and gravity and believing that he should eliminate space theory from physics, tried to relate all laws of nature to human observers and arbitrary frames, instead of to cosmic space and matter. With his general relativity (GR), he even attempted to relate the laws of accelerated and gravitational motion to arbitrary observers and frames, to any rotating, randomly accelerating reference mollusc.[9] It was a bold attempt to extend the restricted or special principle of relativity. Gravity, however, is created by matter; it has nothing to do with any observer's position, motion, or measurements; and neither does inertia. For example, how and why would one attempt to model cosmic motion in the frame of a rotating observer? This is the very same error that Copernicus had to correct. In fact, GR was never interpreted or applied relativistically; its ideas and equations are not applied to arbitrary accelerating or rotating frames, but to the relevant cosmic frame, as determined by the local and distant distribution of matter.

So how did GR achieve its successes? Serendipity is a common occurrence in the history of human inquiry. In formulating GR, Einstein imagined specific observer frames as stand-ins for cosmic space and for the effects of motion in space. To go beyond his observer relativity to space theory, we need only to relate his imaginary frames to cosmic space, to the substance that causes the effects he described.

Consider Einstein's principle of equivalence of inertial and gravitational acceleration. He thought about observers at rest and falling in gravitational fields and sitting on rotating discs, about what they would experience and measure. He realized that gravity was indeed just an acceleration field, as Galileo had discovered. In one of his best-known *gedankens*, Einstein reasoned that an observer in a box being accelerated in deep space by a rocket might reasonably conclude that the box was instead suspended motionless in a gravitational field. Thus, he formulated his principle of equivalence.[10] Now we must ask, relative to what is each observer accelerating? What is the cause of this equivalence? If we are not to again resort to magic, we must find a cosmic-physical explanation.

If space is a substance and the seat of inertia, as Newton asserted, then there is a simple explanation; the rocket-ship observer and the earth-surface observer feel and measure the same acceleration because they are both in a state of acceleration relative to their surrounding inertial space. Because a force is applied to each, by the rocket ship and Earth's surface, respectively, their bodies

are prevented from returning to the natural (force-free) state of nonacceleration relative to space (freefall). There is no simpler nor better explanation for this equivalence; and it leads directly to a working theory of gravity. If Newtonian-inertial space is itself accelerating centripetally towards Earth's center according to the formula $a = GM/r^2$, we obtain the simplest possible explanation for the ballistic-mechanical aspects of gravity. Gravity is an acceleration field, as Galileo had discovered. An observer in freefall in Earth's gravitational field feels no force because he is not accelerating relative to space itself, but is accelerating Earthward with the surrounding inertial space. If he or any matter is prevented from accelerating with space, the strength of their interaction with space produces the force that we call weight ($F = ma$).

Einstein's principle of equivalence thus directly implies that Newton's space is not an absolute solid but a fluid that accelerates towards matter. Matter appears to be a spatial sink, consuming space and thereby causing the surrounding space to flow towards it. This spatial flow must also have a velocity at every point. What would its velocity be, and would it have measureable effects? Can velocity explain the other effects of gravity, the relativistic effects, including the gravitational redshift and the existence of black holes? To investigate this possibility, we must first consider space's second role, as the seat of electromagnetism.

C. Lorentz ether theory over special relativity

If space is a substance, surely it does more than just produce inertia. It must also be the seat of electromagnetism, the substance in and of which electric and magnetic fields are perturbations. James Clerk Maxwell asserted that Newton's absolute space was also the electromagnetic (EM) ether in which light was a wave that propagated at c. He thus produced the equations that remain the foundation of electrodynamics. Hendrik Lorentz further developed Maxwell's theory. He thought about how electrons and their EM fields would be affected by velocity in electromagnetic space and thereby produced the Lorentz transformations that became the cornerstone of relativity. Lorentz ether theory[11] (LET), further developed by Poincaré,[12] considered space to be the medium in which light moved at c, in which moving electrons and therefore all matter were shortened in the direction of motion, and in which moving atoms' electronic spectra were redshifted.

Special relativity (SR) was an observer-based reinterpretation of LET. Indeed, LET is mathematically equivalent to SR for most predictions;[13] however, LET is philosophically superior because it is an objective model of space and motion. Lorentz ether theory replaces the observer and his magical laws with cosmic reality and mechanism and thereby opens up the possibility of understanding relativistic effects. Since it provides the physical medium that causes the observed effects, LET is the best explanation of how and why SR works.[14] In LET, all relativistic effects are physical effects caused by velocity in the electromagnetic medium. Lorentz ether theory eliminates the paradoxes (contradictions) of SR by breaking the symmetry between the relative motions of any two frames. The twin that moves with greater velocity in physical space has the slower atomic clock. A clock at rest in space runs at the fastest rate. Likewise, LET explains the Sagnac effect, the absolute character of velocity in space due to rotation. In LET, the transverse Doppler redshift (time dilation) is not due to space-time perspective but is a physical velocity effect, a frequency reduction that appears to be caused by the dragging of the atoms' bound electrons through a greater amount of EM space (Appendix A).

Therefore, just as the acceleration of a test mass tells us the acceleration of space at any location, the slowing of an atomic clock tells us the velocity of the spatial flow to which it is subjected. Atomic clocks are space speedometers. We determine their spatial velocity by comparing their reduced rate to the fastest rate at which they would run when at rest in space far from any celestial body. Therefore we can continue the transition from relativistic physics to space physics with this second definition: the slowing of an atomic clock (the redshift of an atom's spectrum) reveals its velocity in space.

With our test masses revealing spatial acceleration and our atomic clocks revealing spatial velocity, we have always been detecting real motion in physical space. These definitions allow us to supersede the fruitless abstract debate over absolute versus relative motion. Motion in physical space is real and has physical effects that we can measure. Now we can ask, if the inertial space that appears to flow into all matter in gravity is also the Maxwell–Lorentz EM medium, can its velocity explain gravity's relativistic effects? If so, can it be mere coincidence?

D. Gravity's spatial velocity and the congruence

If space is indeed flowing into matter as into a sink, then both its acceleration and velocity must increase with proximity to Earth's surface. Its velocity will be the result of its total acceleration from rest at infinite distance to Earth's surface, as would be revealed by the motion of a test mass released from rest at an infinite distance. The mass would accelerate with space and therefore remain at rest in space, and its velocity at any height will also be that of the inflowing space. This velocity must be identical to its converse, the initial velocity required at that height to overcome the cumulative Earthward acceleration of space and reach a position of rest at an infinite distance from Earth. This escape velocity is easily calculated in several ways. We can do so on the basis of energy conservation by requiring the kinetic energy T of a particle to equal the total gravitational potential energy V that it must overcome to reach radial infinity with null final velocity:[15]

$$E = T + V = 0 \Rightarrow \frac{1}{2}v^2 = \frac{GM}{r} \Rightarrow v = \sqrt{2\frac{GM}{r}}. \quad (1)$$

Therefore, Newton's escape velocity is also the inflow velocity; both represent the change in velocity caused by the entire accelerational field of Earth from infinity to any r. The velocity of the spatial inflow at any radius r outside any mass M must be:

$$v_{esc} = v_{space} = \sqrt{2\frac{GM}{r}}. \quad (2)$$

Does the evidence indicate that there is such a spatial velocity in a gravitational field? Yes, indeed. The experimentally confirmed formula for the gravitational redshift of atomic spectra, and therefore the slowing of atomic clocks in a gravitational field, is:

$$\frac{\Delta f}{f} = 1 - \sqrt{1 - 2\frac{GM}{rc^2}}. \quad (3)$$

Since in this flowing space $v^2 = 2GM/r$, then by substitution, we see that the gravitational redshift formula is just the Lorentz transformation for the transverse Doppler shift produced by the gravitational spatial velocity:

$$\frac{\Delta f}{f} = 1 - \sqrt{1 - \frac{v^2}{c^2}}. \quad (4)$$

Thus, the expected velocity of this inflowing space at any given height in a gravitational field correctly predicts the gravitational redshift at that height. This derivation is much simpler than Einstein's and follows from a physical theory of space and motion. This theory provides the simplest explanation of this remarkable congruence between Newtonian mechanics and GR. Neither this congruence, nor the behavior of atomic clocks in gravity can be explained relativistically, by observers, frames, and relative motion (Appendix B). This theory unifies the transverse Doppler redshifts caused by motion and by gravity; both are due to velocity in space. Here on the surface of Earth, space is flowing vertically down through us, towards Earth's center, at a velocity of 11.2 km/s. Indeed, an atomic clock on Earth's surface slows just as if it has a velocity of 11.2 km/s. If we place the clock at a higher elevation, it experiences a lower inflow velocity and runs faster. Atomic clocks located in deep space, at rest relative to the surrounding distribution of matter, will have the least spatial velocity and will run at the fastest rate.

There are recognized differences between a gravitational field and the field experienced by an observer in a rocket-ship. In the latter, the spatial flow field is homogenous; it has the same acceleration and velocity at every point in the observer's frame. Gravitational sink flow is inhomogeneous; it is radially oriented, and its acceleration and velocity are greater at every point closer to the gravitator. Interestingly, the equations of spatial flow indicate that it is not an ideal fluid (Appendix C).

Just as matter can move through Newton's space at high velocity with no resistance, so the velocity of the gravitational flow does not affect matter's motion; it does not produce any force on matter, at least not at subluminal spatial velocities. The velocity of gravitating space produces only the known electromagnetic (relativistic) effects. Even though the velocity of space is constant at any given height in a gravitational field, every quantum element of space is accelerating through that location, so matter must accelerate with the surrounding space. Note that this theory has no relationship to the Le Sage theory of gravity or other shielding or pushing gravity models where particles with some small mass fly through a void space, hitting matter, and pushing it towards the earth. This is also not a theory about an ethereal substance moving in space. This is a theory about the gravitational flow of space itself, of a gravitoinertial-electromagnetic quantum fluid (Fig. 1).

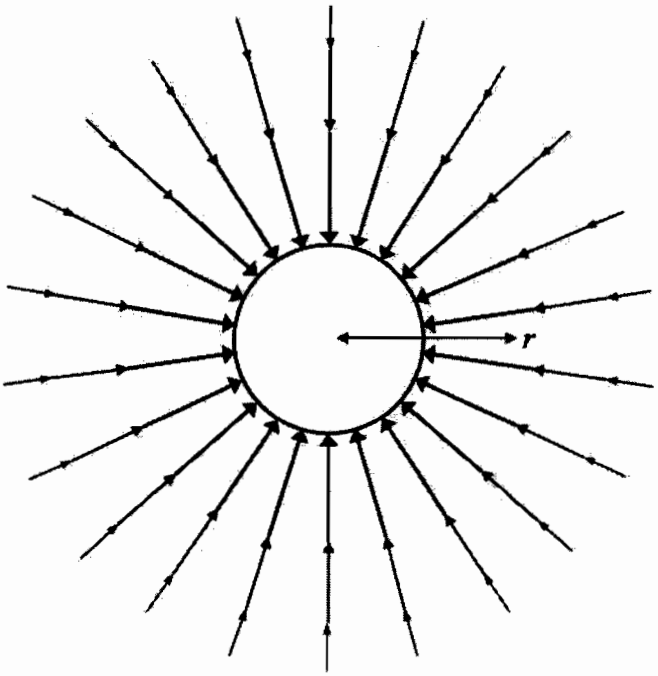

FIG. 1. A two-dimensional representation of the gravitational flow of Newtonian–Lorentzian, inertial-electromagnetic space into all matter. The acceleration of the flow at any height r is GM/r^2, and the velocity is $\sqrt{2GM/r}$. The acceleration explains the ballistic effects of gravity; the velocity explains the electromagnetic (relativistic) effects.

E. Flowing space over general relativity

Can this flowing space theory reproduce the other successful predictions of GR? Indeed it can and with greater simplicity. In the early 1920s, Gullstrand[16] and Painlevé[17] demonstrated that the Schwarzschild metric could be represented by a flat space flowing radially inward towards matter at the Newtonian escape velocity. Herbert Ives and Robert Kirkwood published more detailed treatments of this model between 1939 and 1954. Ives demonstrated that if an object in a gravitational field were affected as if it had the Newtonian 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.[18,19] Whereas Ives considered these effects to occur in an isotropic nonflowing Newtonian–Lorentzian space, Kirkwood treated them as due to the actual flow of Newtonian–Lorentzian space into all matter.[20,21] More recently, Tom Martin demonstrated that, for an isolated gravitational attractor, a Galilean frame with a spatial inflow or outflow of speed $w(r) = \pm\sqrt{2GM/r}\hat{e}_r$ gives all of the correct general relativistic physical effects usually associated with the static and curved space-time Schwarzschild solutions.[22] Reginald Cahill asserts that space is a quantum foam system and has shown that Newtonian gravity and GR can be explained by the flow of space into matter.[23] Many nonphysicists have independently produced the flowing space theory.[24]

I produced this flowing space theory myself, in isolation, by the logic here described, using only my memory of Newton's laws and a copy of Einstein's popular book on relativity.[25] I predicted the gravitational redshift; and only much later did I find that this prediction was consistent with GR and with observations. How did Einstein impute the correct velocity to space without recognizing it as such? Certainly he could not think about space as a substance to which motion was uniquely related without abandoning the relativity program. In order to conceive of the velocitylike effects of gravity he used abstract work-energy concepts. He imagined a completely nonanalogous situation, that of an observer on the edge of a rotating disc.[26] Considering the observer's velocity and the work needed to move a unit mass from the observer to the center of the disc, Einstein associated the disc observer's velocity with a quasigravitational potential $\varphi = v_{obs}^2/2 = -\omega^2 r^2/2 = -GM/r$. He was then able to relate this potential ($\equiv v^2$) to the Lorentz transformation $f = f_O\sqrt{1 - v^2/c^2}$ and predict a gravitational redshift of $f = f_O\sqrt{1 - GM/rc^2}$. However, this is less than the true velocity effect of gravity by a factor of $\sqrt{2}$.[27] He had to double the gravitational potential term to $-2GM/r$ to get the correct gravitational velocity redshift formula $f = f_O\sqrt{1 - 2GM/rc^2}$. How he realized that he had to double the rotating disc work potential to describe the relativistic effects of gravity is a question that I must leave to others to answer.

General relativity does get many predictions right, but it can never be proven. It is an overly complex, highly abstract mathematical scheme (e.g., space-time intervals, gravitational potentials, various tensors) that provides no physical insight into what gravity actually is. The curvature of space-time is just a description of gravity's effects on the observer's measurements, not a theory of the cause. I submit to you that Eddington overestimated, that in fact no one actually understands GR. What experts in GR acquire, with their many years of training, is the ability to do the calculations.

This flowing space theory explains and simplifies the known phenomena. It offers insights into other current problems in physics and Cosmology, which I intend to address in another paper. It also produces predictions not found in relativity (Appendix D). However, it leaves us with two mysteries: What causes space to flow into matter, and what causes the marked contraction or deformation of space in a gravitational flow? These are just mysteries; they involve neither contradiction nor impossibility. They are mysteries no more profound than those unveiled by Copernicus's theory that the earth was floating in space and rotating as it flew around the sun at 30 km/s. Now as then, solving the mysteries will be the source of new insights into nature.

F. Black holes

If a celestial body is sufficiently massive and compact, then the spatial inflow velocity at some point outside its surface will be $\geq c$. If light is, as the evidence suggests, a wave that propagates in space at c, then it could not exit against the superluminal inward flow of the medium. This is the simplest, most plausible physical explanation for the confinement of light by a black hole. With flowing space, we obtain the Schwarzschild radius[28] R_S by solving Newton's escape velocity Eq. (2) for r and setting the spatial inflow velocity equal to c:

$$R_S = 2\frac{GM}{c^2}. \tag{5}$$

The event horizon is defined by Newton's escape velocity; it is where the spatial inflow attains the velocity c. This derivation is much simpler than Schwarzschild's[29] and follows from a plausible physical theory of gravity. This theory of black holes implies no singularity or loss of information or wormhole or other universes. A black hole is just a conglomeration of matter so massive and compact that light cannot propagate out through the space that is flowing inward at $\geq c$. The matter of a black hole need not even be in an exotic state; it could be composed of densely packed neutrons. A neutron star of density 5×10^{17} kg/m^3 and mass six times that of the sun (6 M_{sun}) would have an inflow velocity of c at its surface. Its physical radius of 18 km would also be its luminal (Schwarzschild) radius. A neutron star of 60 M_{sun} would have a physical radius of 38.6 km and a luminal radius of 178 km. The spatial velocity at its surface would be $2.1c$. The black hole at the center of the Milky Way[30] Sagittarius A*, with a mass 4×10^6 M_{sun}, would have a luminal radius of 12 million km. If also composed of neutrons, its physical radius would be 1600 km, slightly smaller than the moon. Its surface inflow velocity would be $86c$.

The idea that space is flowing into black holes is not only mathematically accurate but is so intuitively attractive that it is frequently used to describe black holes in popular presentations.[31,32] It has been called the "river model" of black holes in which "space itself flows like a river through a flat background, while objects move through the river according to the rules of special relativity. . . the river of space falls into the black hole at the Newtonian escape velocity. . ."[33] These scientists fail to mention, however, that flowing space also correctly

models the ballistic and relativistic effects of normal weak gravity. They fail to see it as anything more than an appealing analogy.

IV. SPACE PHYSICS

Space theory is a new program for physics. It takes us beyond the observer-centric confines of Einstein's and Popper's positivistic science. Its fundamental hypotheses, like the existence of the cosmos apart from our consciousness and the physicality of space, are not falsifiable as they are necessary to any plausible explanation of what exists and causes our conscious experiences. Regarding space, we are simply ignorant; we are in the same position as were the ancient Greeks regarding air. They could not see air, but they could see and feel its effects. Likewise, we cannot see space, but we can observe its effects everywhere. Up to now, we have only been describing those effects as mathematical regularities in our experiences and measurements, as laws of physics. Space theory requires us to explain the laws and thus opens up a new, deeper level of cosmic reality.

Space itself cannot have mass, inertia, or electrical charge because it is the seat, the cause of these phenomena.[34] In order to produce the uniformity we observe, it must have the smallest parts of some size, the ultimate quanta. Perhaps it is a quantum foam composed of cells at the Planck length (10^{-33} cm). Where there are no cells, there is no space; there is nothing, a void. No physical phenomena can enter a void or exist within it. These spatial quanta cannot be simple; they must be sufficiently complex to produce all the physical phenomena that we observe and to support the hierarchical evolution of complexity: From spatial to subatomic to atomic to molecular, biological, neurological, psychological, and linguistic levels of organization.

We need to reinterpret all existing concepts in theoretical physics and recycle all that is true and useful from Newtonian mechanics, relativity, QM, and other models. Rather than manipulate abstract concepts and equations, we will try to understand the physical entities and processes involved. Even a concept as simple as length should not be viewed as only a measurement or dimension. Length represents a physical reality, some number of spatial cells. Time, likewise, is not just a measurement or a dimension. Time cannot dilate. Time is our way of representing cosmic evolution, the unending procession of cause and effect. We use various regular cause-effect processes as clocks. All clocks have physical mechanisms that are affected in various ways under various physical circumstances (e.g., velocity, temperature, acceleration). We will no longer speak of energy as if it were some mysterious vital force. Francis Bacon realized long ago that every form of energy is a form of motion.[35] So we should always ask, motion of what, motion in what? In space physics, mass and energy are not irreducible entities. They are both forms of motion in/of space; the one more organized, the other less so. From this essential identity follows their interconvertibility and mutual conservation.

Fields (e.g. electromagnetic and gravitational) also are states of the medium, distortions of and/or motions of and within space. Electrons, hadrons, muons, neutrinos, etc. are not self-existent particles in a void; they are various persistent patterns of various kinds of motion in/of space. When particles are altered or annihilated, their organized internal motion is released in less organized forms. As we come to understand spatial processes, we will gain insight into the mechanisms of particle formation, transformation, and annihilation.

Space physics will proceed by physical conjectures. We will then use observations and experiments to support or weaken our conjectures and reveal unknown phenomena. Mathematics will serve to add precision and structure to our theories, not as a substitute for physical theory. We will not tolerate paradoxes but, instead, eliminate them by producing a better theory. As a theoretical science, space physics will more closely resemble our other natural sciences, chemistry, geology, and biology.

V. CONCLUSION

This theory of space and its gravitational flow is philosophically superior to Newtonian mechanics, relativity, and QM:

(1) It is completely a cosmic-objectivistic theory. It replaces our observer-based accounting models with a physical theory of what is really moving relative to what, of what exists and is causing the effects we experience and measure.
(2) It explains gravity in the simplest possible way, as the acceleration and velocity of a flowing gravito-inertial electromagnetic space.
(3) It unifies inertial and gravitational acceleration. Both are the result of acceleration relative to physical space. It explains Einstein's principle of equivalence.
(4) It expands Einstein's principle of equivalence to include velocity, unifying inertial and gravitational velocity. The relativistic effects of gravity are velocity effects.
(5) It explains the congruence between Newton's escape velocity and the Schwarzschild solution.
(6) It relates relativistic phenomena to a quantized physical substance, thereby eliminating the paradoxes of relativity. It eliminates the GR-QM schism by superseding both models.
(7) It provides a plausible physical theory of black holes.
(8) It explains relativistic effects as electromagnetic effects, thus unifying these phenomena.
(9) It unifies all physical phenomena, as due to various motions or distortions in and of a single substance. It explains mass-energy equivalence and conservation.

Space theory places theoretical physics on the proper foundation of physical causation. It restores physics to philosophy, and philosophy to its proper role as the most

effective use of our linguistic intelligence. It has many implications and raises innumerable new questions. Space theory has the potential to revolutionize our understanding of the cosmos and of ourselves in ways that we cannot anticipate.

Appendix A: The transverse Doppler redshift (slowing of atomic clocks)

If space is the EM medium, the Doppler redshifting of the spectra of atoms must be due to a physical interaction between their bound electrons and the space in which they are moving. Much evidence suggests that electrons are composed of EM waves; they are EM wave structures. When an electron is bound to nucleus, its waves surround or propagate about the nucleus in one of the shapes we call "shells". When the nucleus is moving through space, the electron's waves must propagate through a greater spatial distance as they circle the nucleus. The increased distance is described by the Pythagorean theorem, which is the basis of the Lorentz transformations. It corresponds precisely to the bouncing light clock analogy used in introductions to special relativity (SR), although the analogy is attributed to relativity moving frames instead of motion in the physical frame. Since any bound electron's wave number n is fixed, each wave must be forced to traverse more space. The wavelength must increase and the frequency decrease. As a bound electron's frequency is redshifted, so are the frequencies of the light quanta it absorbs and emits. This is the transverse Doppler redshift. This physical explanation is a crude first attempt, for we know little about electrons and their relationship to nuclei. Interestingly, free electrons are not redshifted by velocity in space. Their internal frequency increases with velocity ($E_{free} = hf$). There is no time dilation for free electrons.

Appendix B: Relativity and the equivalence of gravitational and inertial velocity

Can relativity explain why the gravitational redshift is perfectly described as by Newton's escape velocity? Can one explain this congruence between these very different models of gravity without the flowing space hypothesis? I think not. Most textbooks on GR do not mention it. One author dismissed the congruence as a fortuitous coincidence;[36] another admitted that he could find no explanation.[37] In a paper dedicated to solving this mystery, the author demonstrated only that the Schwarzschild solutions incorporate the escape velocity equation without explaining why.[38] I submit that the why requires the flowing space theory. A previous reviewer did offer a relativistic explanation. He claimed that the velocity equivalence is a consequence of the principle of equivalence (PoE) of gravitational and inertial acceleration and does not require the flowing space hypothesis. He argued that an observer falling toward Earth from rest at an infinite distance (*in vacuo*) would accelerate to a velocity of 11.2 km/s at Earth's surface; thus, to him, a clock on Earth's surface would appear slowed when he passed by it. Does this explain the congruence? Consider that:

(1) To apply relativity, one must assert that the 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 and measure. On the contrary, atomic clock slowing on Earth's surface is evident to the earth-surface observer, even though he is not in freefall and has no velocity relative to the clock. He can put a clock on a high tower and see that it runs faster, even though it remains at rest relative to him. This fact demonstrates the objective and physical nature of this gravitational effect and exposes the artificiality of trying to explain gravitational clock slowing using falling observers.

(2) We know that inertial acceleration, as in a centrifuge, does not slow atomic clocks or increase the life of muons, whereas gravity and velocity do. So the gravitational acceleration cannot explain gravitational clock slowing. The only link that Einstein made between SR, acceleration, and velocity in his presentations of GR was his aforementioned thought experiment involving the slowing of clocks due to their velocity on the periphery of a rotating disc,[39] 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 (escape velocity) with the known acceleration at any height requires an additional assumption (freefall from infinity) that stipulates the velocity and indicates that only one falling frame has physical significance. This violates the strong version of the PoE. Flowing space, on the other hand, directly predicts this velocity on the basis of a plausible physical model of gravity.

(3) Relativists apply the Lorentz transformations to this one falling observer's velocity to explain the slowing of the clocks (the observer falling from rest at infinity), but SR does not provide the needed velocity assumption. Special relativity does not treat gravity or acceleration and thus cannot predict and or explain why gravity produces this unique apparent velocity at a given height. To invoke SR here is to violate the equivalence principle of SR, the doctrine that SR is valid in every freely falling frame. One would need to admit, instead, that in this cosmos where gravity is present everywhere, SR is valid only in those frames that fall from rest at infinity towards the center of the gravitational mass. These frames constitute a radial array that resembles a field of flow, whose velocity at every point outside a mass equals the escape velocity. Such an admission simply mimics the flowing space theory here presented.

Therefore, the expanded PoE of inertial and gravitational velocity that was predicted and explained by this

theory cannot be explained within relativity by appeal to observers using the accelerational PoE and/or SR.

Appendix C: The gravitational deformation or contraction of space

Space's gravitational flow acceleration is proportional to $1/r^2$, whereas that of an ideal fluid approaching a sink is proportional to $1/r^5$. The gravitational velocity is proportional to $1/\sqrt{r}$, whereas an ideal fluid's velocity approaching a sink is proportional to $1/r^2$. So beginning at an infinite distance, the gravitational velocity and acceleration of space as it approaches matter increases more slowly than expected for an ideal fluid. Likewise, outside a mass with a given surface spatial velocity and acceleration, the gravitational acceleration and velocity both fall off much more slowly with distance than in an ideal fluid.[40] The spatial flow here described is therefore nonideal, non-Euclidean. It appears that, as space flows towards matter, there is either:

(1) A disappearance of some spatial cells, or
(2) A progressive symmetrical volume loss of all spatial cells, or
(3) A deformation of all spatial cells, a radial elongation and lateral narrowing.

In all cases above, the cells must also rearrange or stream in order to produce the apparent flow. If there is a radial elongation and lateral pinching (spaghettification) of the individual spatial elements as they approach matter, this would produce a lower apparent cell flow rate, a lower spatial velocity as measured by our atomic clocks. Modeling any contraction or deformation of spatial cells is difficult, for the distances we measure with rods or light signals are themselves affected by any alteration in the size and shape of the spatial elements. Oddly, if space were indeed spaghettified near matter, there is no way for the observer in this space to appreciate this distortion as he and his instruments would also be spaghettified. Only a Euclidean, extracosmic observer who was not affected by variations in spatial cell size could measure the true distances and accurately characterize the cells' size and shape at every location. This deformation or contraction of space occurs even at very great distances from matter. Gravitational flow is unlike any flow that we know. It is mysterious, but not impossible.

Appendix D: Tests of gravitational spatial flow

As discussed above, this theory of spatial flow is philosophically superior to GR; it makes sense of the phenomena in the context of all that we know. The nature of space and of gravity is a philosophical question. Experiments alone can never prove or disprove GR or flowing space for a number of reasons. Special relativity and GR contain the Newtonian and Lorentzian equations, and physicists have and will apply these equations in whatever fashion and to whatever frame gives the right answer, in violation of the relativity program. Also, it is impossible to locally measure spatial flow for the reasons put forward by Lorentz and Einstein: the slowing of atomic clocks, the length contraction, and the problem of synchronizing clocks using the very phenomena one is trying to study. Yet flowing space may yet be supported experimentally as it produces kinematic effects not found in static-space models, such as the Newton–Lorentz ether model or Einstein's space-time model. 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 $c - 11.2$ km/s relative to Earth's surface. Light falling downwards towards Earth will move at $c + 11.2$ km/s. All celestial bodies should produce a corresponding differential velocity. This should be detectable if present. The very existence of black holes is, I would suggest, proof of this anisotropy. A vertical interferometer will be of no help to detect the vertical spatial flow as it could be affected by a Lorentz–Fitzgerald contraction, and gravitational acceleration causes a marked compaction of any material in the vertical direction.
(2) It may be possible to devise experiments with atomic spectra or atomic clocks that could differentiate flowing space from static-space theories. The spectra of atoms falling towards vs moving upwards away from Earth's surface at a given velocity relative to Earth should suffer very different transverse Doppler redshifts. Atoms falling in Earth's gravity are moving with the flow of space and will have a smaller spatial velocity and redshift, while atoms rising upwards against the flow of space will have a higher spatial velocity and redshift. Likewise, muons rising against the 11.2 km/s spatial inflow at near c relative to Earth will suffer a greater frequency reduction and therefore persist longer than muons falling with the flow. An atomic clock falling in Earth's gravity should run faster than one rising away from the earth at the same velocity relative to the earth's surface. The Vessot–Levine rocket experiment[41] involved an atomic clock rising and falling in Earth's gravity, but it was complex in design and based on relativistic assumptions. One analyst concluded that it could not distinguish between relativity's static-curved space (-time) and flowing space.[42]
(3) In flowing space, matter may be observed falling into celestial bodies at velocities greater than c (relative to the gravitator). If a mass is moving towards the gravitator at near c in space, and space is flowing inward at near c, then its velocity relative to the black hole can approach $2c$ before it reaches the luminal horizon. Martin has demonstrated that spatial sources, with space flowing outwards in all directions, would produce gravitational acceleration and velocity gradients and effects similar to those of spatial sinks.[43] Therefore, astronomical observa-

tions may detect light or matter moving away from spatial sources at velocities $>c$. Relativity excludes velocities $>c$ or $<c$ in any frame.

(4) Martin has argued that, at the boundary between the spatial flows of two bodies, there may be anomalous atomic clock slowing 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 the 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.[44,45]

[1]H. H. Lindner, Phys. Essays **15**, 113 (2002).
[2]*ibid.*
[3]I. Newton, *Mathematical Principles of Natural Philosophy* (1686), Defs, Scholium, para. 9.
[4]A. Einstein, *Sidelights on Relativity* (Dover, New York, 1983), Ether and the Theory of Relativity, pp. 23–24.
[5]R. B. Laughlin, *A Different Universe: Reinventing Physics from the Bottom Down* (Basic Books, New York, 2005), pp. 120–121.
[6]F. Wilczek, *The Lightness of Being, Mass, Ether, and the Unification of Forces* (Basic Books, New York, 2008), p. 89.
[7]*ibid.*, p. 74.
[8]E. A. Burtt, *The Metaphysical Foundations of Modern Physical Science* (Doubleday, Garden City, 1924), pp. 270–276.
[9]A. Einstein, *Relativity, The Special and General Theory* (Crown, New York, 1961), p. 99.
[10]*ibid.*, p. 66.
[11]H. A. Lorentz, *The Electromagnetic Theory of Maxwell and its Application to Moving Bodies* (E. J. Brill, Leiden, 1892).
[12]H. Poincaré, Rendiconti del Circolo matematico di Palermo **21**, 129 (1906).
[13]R. Mansouri and R. Sexl, General Relat. Gravit. **8**, 497 (1977).
[14]G. Builder, Aus. J. Phys. **11**, 279 (1958).
[15]G. Preti, Found Phys. **39**, 1046 (2009).
[16]A. Gullstrand, Arkiv. Mat. Astron. Fys. **16**, 1 (1922).
[17]P. Painlevé, C. R. Acad. Sci. (Paris) **173**, 677 (1921).
[18]H. Ives, J. Opt. Soc. Am. **29**, 183 (1939).
[19]H. Ives, J. Opt. Soc. Am. **38**, 413 (1947).
[20]R. Kirkwood, Phys. Rev. **92**, 1557 (1953).
[21]R. Kirkwood, Phys. Rev. **95**, 1051 (1954).
[22]T. Martin, arXiv:gr-qc/0006029v1 (2000).
[23]R. T. Cahill, arXiv:physics/0307003v1 (2003).
[24]C. Ranzan, http://www.cellularuniverse.org; P. C. M. Hahn, http://www3.telus.net/foamyether; H. C. Warren, http://www.hcwarren.com; F. Stefanko, http://spaceflow.sk; J. R. Warfield, http://www.worldnpa.org/site/member/?memberid=224&subpage=abstracts.
[25]A. Einstein (1961) *op. cit.*
[26]*ibid.*, p. 79.
[27]*ibid.*, p. 130.
[28]I. R. Kenyon, *General Relativity* (Oxford University Press, Oxford, 1990), p. 107.
[29]See discussion in G. Preti *op. cit.*
[30]R. Schödel, T. Ott, R. Genzel, R. Hofmann, M. Lehnert, A. Eckart, N. Mouawad, T. Alexander, M. J. Reid, R. Lenzen, M. Hartung, F. Lacombe, D. Rouan, E. Gendron, G. Rousset, A.-M. Lagrange, W. Brandner, N. Ageorges, C. Lidman, A. F. M. Moorwood, J. Spyromilio, N. Hubin, and K. M. Menten, Nature **419**, 694–696 (2002).
[31]M. Tegmark, in *Seeing Black Holes*, dir. S. Cooter, BBC/Science Channel (2010).
[32]B. Cox, in *Wonders of the Universe, The Known and the Unknown*, dir. C. Holt, BBC/Science (2011).
[33]A. J. S. Hamilton and J. P. Lisle, Am. J. of Phys. **76**, 519 (2008), arXiv:gr-qc/0411060v2 (2006).
[34]A. Einstein (1983) *op. cit.*, p. 19.
[35]F. Bacon, *Novum Organum* (1620), Second Book of Aphorisms, xx.
[36]P. G. Bergmann, *The Riddle of Gravitation* (Dover, New York, 1992), p. 195.
[37]N. K. Glendenning, *Special and General Relativity* (Springer, New York, 2007), p. 176.
[38]G. Preti *op. cit.*
[39]A. Einstein (1961) *op. cit.*, p. 81.
[40]C. Ranzan, http://www.cellularuniverse.org/Th5AetherEqns.pdf (2008).
[41]R. F. C. Vessot, M. W. Levine, E. M. Mattison, E. L. Blomberg, T. E. Hoffman, G. U. Nystrom, B. F. Farrel, R. Decher, P. B. Eby, C. R. Baugher, J. W. Watts, D. L. Teuber, and F. D. Wills, Phys. Rev. Lett. **45**, 2081 (1980).
[42]R. Benish, Apeiron **15**, 3, 222 (2008), available at: http://redshift.vif.com/JournalFiles/V15NO3PDF/V15N3BEN.pdf.
[43]T. Martin, *op. cit.*
[44]T. Martin, arXiv:gr-qc/9807006v3 (1999).
[45]T. Martin, arXiv:gr-qc/9806033v2 (1999).