A Unified Model of the Gravitational, Electrostatic, and Magnetic Forces

What follows is an informal continuation of the work presented in, "*A Computational Model of Time-Dilation*" [1],[1] in which we presented a theory of time-dilation rooted in information theory and computer theory, with equations for time-dilation that are identical in form to those given by the special and general theories of relativity. In this note, we present a unified model of the Gravitational, Electrostatic, and Magnetic Forces that is consistent with the model of physics we presented in [1], thereby presenting the outlines of a complete, and unified model of physics.

The Energy of a Field

Force-Carriers

In [1], we presented a model of physics in which all energy is quantized into integer multiples of the minimum energy E_0 (see Section 3 of [1] generally), which we call a **quantum** of energy. We assume that each quantum of energy is always in one of two categories of states: a mass state, which generates mass, and a kinetic state, which generates motion through physical space (see Section 3.1 of [1]). Further, we showed that our model implies that the momentum of a particle is proportional to the rate at which the total energy of the particle traverses a point in space along its path (see Section 3.6 of [1], as well as "*Mass, Energy, and Momentum*"[2]). Because we assume that energy is conserved, it follows that a field cannot exchange energy or momentum with a particle unless the field itself contains energy.

As such, we assume that the gravitational, electrostatic, and magnetic fields each consist of quanta of energy that constitute the **force-carriers** of their respective fields. We do not, however, assume that each field consists of the same force-carrier particle, but rather, we assume that, as a general matter, each of these three fields consists of a set of particles that exchange energy and momentum with the particles with which they interact.

The Frequency of a Field

As noted above, we assume that the gravitational, electrostatic, and magnetic fields all consist of force-carrier particles. In the case of the gravitational and electrostatic fields, we assume that these force-carriers emanate from a mass, or charge, respectively, and travel outwardly in every direction at a velocity of c (see Section 4.1 of [1]). We address the frequency of a magnetic field separately below in the section entitled, "*The Force-Carrier of a Magnetic Field*". Further, we assume that if the structure of a given mass or charge (in each case, the "system") is stable, then the frequency with which the force-carriers of the field traverse any given point in space around the system is also stable. We call this the **frequency** of the field at a given point in space. That is, we do not assume that the force-carriers of the field are omnipresent, but rather, that they

[1] Available at www.researchgate.net/publication/323684258_A_Computational_Model_of_Time-Dilation.
[2] Available at https://www.researchgate.net/project/Information-Theory-16/update/5bce406b3843b006753fda45.

emanate from the system, in all directions, at a velocity of c, which, for a stable system, will generate a stable frequency with which the force-carriers traverse any given point in space.[3]

The Probability of Interacting with a Field

The model of time we presented in [1] is effectively discrete, in that systems change properties and positions only upon the occurrence of a "click", which happens simultaneously, everywhere, every t_0 seconds (see Section 3 of [1] generally). Nonetheless, we show that our model allows for time-dilation using objective time, with equations that are identical in form to those given by the special and general theories of relativity. In short, all systems update their properties and positions only upon the occurrence of a click, but the more kinetic energy a system has, the more objective time the system spends updating its position, rather than its properties, causing systems to "age" at objectively different rates, ultimately generating time-dilation (see Section 3.2 of [1], as well as, "*On the Value of Gamma*" [2][4]).

Because there is some frequency with which the force-carriers of a field will traverse a given point in space, if we consider a given interval of time, there will be some number of clicks for which a force-carrier is located at that point. For example, assume that, for a given point in space, over t seconds, a force-carrier was located at that point for exactly N clicks. It follows that $N = ft$. That is, we interpret f as the number of times per second that a force-carrier is actually located at a given point in space, and we assume that its presence there lasts for exactly one click. More generally, if the force-carriers of a field traverse a given point in space, then we assume that those force carriers are actually located at that point for exactly one click.

Therefore, we can define the **probability of interaction** with the field at that point in space as,

$$p = f\,t_0. \qquad \text{(Eq. 1)}$$

That is, p is the portion of clicks for which a force-carrier is expected to be located at the point in question. Returning to our example, p would in this case be given by $(N\,t_0) / t = f\,t_0$.[5] Note that, for simplicity, we are tacitly assuming that a force-carrier will interact with any particle that is co-located at a given point in space upon a given click with certainty. For a more rigorous treatment of this topic, where we do not make this assumption, see Section 4.1 of [1].[6]

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[3] Though we assume that, as a general matter, energy is conserved, we do not present a complete theory as to the ultimate origin of the energy that is contained within fields, though we do address this topic in part below in the section entitled, "*Conservation of Energy and Momentum*". Similarly, we do not attempt to explain the origin of gravity, or charge, but rather, assume that a particle with mass generates a gravitational field, and a particle with charge generates an electrostatic field. We do, however, present a novel theory of magnetism in [3], as the result of the displacement of charges, which we discuss below in the section entitled, "*Matter as a Computational Engine*".

[4] Available at https://www.researchgate.net/project/Information-Theory-16/update/5bce406b3843b006753fda45.

[5] Note that while the units of p are not truly dimensionless, since it is a measure of the expected number of interactions at a given point in space per click, because t_0 is the minimum time, p will necessarily be less than or equal to 1.

[6] That is, even in the case where $f = 1 / t_0$ (which is the maximum frequency, since t_0 is the minimum time) we do not have to assume that $p = 1$. Rather, we could allow for the probability of interaction to be dependent upon other

The Expected Force of Interaction with a Field

We assume that the force-carriers of a field act on a particle by exchanging energy, momentum, or both with the particle. Specifically, in the case of a magnetic field, we assume that a charge displaced in a magnetic field does not exchange energy with the magnetic field, but does exchange momentum with the magnetic field. That is, we assume that magnetic force-carriers do not exchange energy with charges, but rather, exchange only momentum. As a general matter, this allows us to express an interaction with a force-carrier as a force (i.e., a rate of change in momentum), which we assume to be caused by an exchange of energy or momentum, or both, between a particle and a force-carrier.

We assume that any such interaction occurs only upon a click where a particle is co-located with a given force-carrier. As a result, the expected change in momentum per click at a given point in space will depend upon (1) the probability of interaction at that point, and (2) the expected amount of momentum exchanged between the particle and the force-carrier per interaction. Therefore, we can express the **expected change in momentum** per click at a given point in space as,

$$\Delta\rho = p\,\Phi, \quad \text{(Eq. 2)}$$

where p is the probability of interaction at the point in question, and Φ is the expected amount of momentum exchanged per interaction, which could also vary depending upon the point in question. That is, $\Delta\rho\,(t / t_0)$ gives the total expected change in momentum due to interactions with a field at a given point in space over a period of t seconds, which would be the result of $p\,(t / t_0)$ interactions between a particle and the force-carriers of the field. Expressed as a force, we have,

$$F = \Delta\rho / t_0 = f\,\Phi.$$

As such, Equation (2) allows us to express the change in momentum of a particle in a gravitational, electrostatic, or magnetic field as the result of the repeated application of a force, ultimately due to repeated exchanges of energy, or momentum, or both, with a field comprised of force-carrier particles. Specifically, Equation (2) allows us to view the change in momentum of a photon in a gravitational field as the result of a series of interactions in which the photon gradually changes its direction of motion, without space-time, by exchanging energy and momentum with force-carrier particles, which we discuss in greater detail below in the section entitled, "*The Behavior of Light in a Gravitational Field*".

Time-Dilation Due to Interactions with a Field

We assume that whenever a particle interacts with a field upon a given click, the particle does so in lieu of updating its properties. As a result, in our model, a particle that interacts with a field will experience time-dilation, whether it is due to interactions with a gravitational field,

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factors, beyond frequency, such as interference between the force-carriers themselves, which we discuss in Section 4.1 of [1].

electrostatic field, or magnetic field. Specifically, if $\bar{t}$ is the expected lifetime until decay of a given particle when stationary, outside of any field, and p is the probability of interaction at the point in space occupied by the particle within a field, then the expected lifetime of the particle when stationary at that point within the field is given by,

$$t = \bar{t} / (1 - p). \qquad \text{(Eq. 3)}$$

That is, some portion of the objective time that elapses is spent by the particle interacting with the field, in lieu of the particle changing states, thereby causing time-dilation, and extending the expected lifetime of the particle (see Sections 3 and 4.1 of [1], as well as [2] generally).

The Behavior of Light in a Gravitational Field

The model of time-dilation presented in [1] implies that light is incapable of experiencing time-dilation. Specifically, light is perfectly stable in our model, and as a result, it has no states to progress through. Instead, a photon transitions through physical space upon each click, ultimately causing it to propagate at a velocity of c. However, photons are of course capable of interacting with other particles, exchanging energy, momentum, or both. In our model, this necessarily implies that these interactions occur in lieu of the photon's propagation through space. That is, if a photon interacts with another system or particle upon a given click, then it does so in lieu of propagating through space. This implies that a photon should propagate through a medium at a velocity of less than c, which is indeed the case.

Because our model views gravitational fields as being filled with force-carrier particles that interact with exogenous particles, it follows that a gravitational field could be viewed as a medium through which light propagates. This is consistent with the fact that photons gain energy when entering a gravitational field, lose energy when exiting a gravitational field, and change momentum when traversing a gravitational field, thereby following a macroscopically curved path. In addition, our model implies that a photon would also "slow down" when interacting with a gravitational field, since these interactions necessarily occur in lieu of the photon propagating through space.

In [1], we showed that the probability of interaction at any point in space at a distance of r from the center of a system with a mass of M that generates a uniform gravitational field is given by,

$$p = 1 - \sqrt{1 - \frac{2GM}{rc^2}}\,. \qquad \text{(Eq. 4)}$$

Returning to Equation (3), it follows that if the expected lifetime of a particle is $\bar{t}$ seconds when the particle is stationary outside of the gravitational field of the system, then the expected lifetime of the particle at a distance of r from the center of the system is given by,

$$t = \bar{t} / \sqrt{1 - \frac{2GM}{rc^2}}\,,$$

which is consistent with the general theory of relativity. That is, the particle experiences more time-dilation as it gets closer to the system, and less time-dilation as it moves further away from the system, since the probability of interaction increases as the particle gets closer to the system.

Returning to the case of a photon within a gravitational field, as noted above, a photon is not capable of experiencing time-dilation, but does nonetheless interact with gravitational fields. Though the probability of interaction between a gravitational field and a photon could be different than the probability of interaction between a gravitational field and a mass, the probability of interaction between a gravitational field and a photon cannot be zero, since photons clearly interact with gravitational fields. As a result, our model implies that the velocity of a photon should deviate from the exact value of c whenever a photon traverses a gravitational field, but the amount by which it should deviate is not obvious. If the probability of interaction is on the order of that given by Equation (4), then any such deviation should be extremely small.

Specifically, our model implies that the velocity of a photon through a gravitational field is,

$$v = c\,(1 - p), \qquad \text{(Eq. 5)}$$

where p is the probability of interaction between the photon and the gravitational field, which, for simplicity, we have assumed to be constant.

A Simple Theory of Black Holes

Because our model of physics does not make use of space-time, we must present an explanation for the emergence of a black hole that does not make use of the warping of space-time. If we return to Equation (4), we see that there is a distance from the center of a mass at which the probability of interaction will be 1. Specifically, if $rc^2 = 2GM$, then the probability of interaction will be 1. In this case, r is commonly known as the **Schwarzschild radius**. That is, at any point in space at a distance of the Schwarzschild radius from a mass, the probability of interacting with the gravitational field will be 1.

Ordinarily, the Schwarzschild radius of a macroscopic object is inaccessible because it is, for even an extraordinarily massive object, very small, and therefore, contained within the physical boundaries of the object. We can, therefore, define what is commonly referred to as a **black hole** as any system with a Schwarzschild radius that extends beyond its macroscopic physical exterior. That is, the Schwarzschild radius of a black hole is "outside" of its external physical boundaries, meaning that it is physically accessible.

Because we assume interactions with a gravitational field occur in lieu of a particle updating its properties or positions, it follows that any particle at a distance of the Schwarzschild radius from a mass will be effectively "trapped" both in space and in time. That is, the interactions between a particle and the gravitational field become so frequent that the particle stops moving, and stops changing states, meaning that it experiences the maximum possible time-dilation.[7] Because the probability of interaction increases as a particle gets closer to the center of a mass generating a gravitational field, this reduction in physical velocity and increase in time-dilation should occur gradually. Taken together, this implies that whenever the Schwarzschild radius extends beyond the macroscopic physical exterior of a mass, it should be possible to observe particles that are initially accelerated due to interactions with the gravitational field, and then gradually decelerated, as the interactions reach a tipping point at which they occur so often that the particle actually begins to lose velocity, until it is eventually unable to move at all, upon arrival at the Schwarzschild radius.

Finally, because our model of gravity does not make use of space-time, there is nothing that would prohibit the existence of repulsive gravity. In fact, in our model, the absence of a repulsive force of gravity would leave an inexplicable asymmetry between the gravitational and

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[7] Observation suggests that velocity is, as a general matter, capped at c, the velocity of light. Similarly, our model assumes that the total velocity of a particle (i.e., the norm of its velocity through both its state-space and physical space) is constant, and is always equal to c (see [2]). As a result, as a particle accelerates through physical space, its velocity through its state-space decreases, causing the particle to experience time-dilation. That is, time-dilation increases as a function of velocity, which is consistent with observation. As a result, either there is an exception to the general rule that the total velocity of a particle is always c, or, that when a particle enters a black hole, it begins to lose velocity in both physical space and the state-space, and accelerate in another space altogether. Under this view, there are three dimensions of space: physical space, the state-space (i.e., a particle's own particular set of possible states), and another space altogether.

Assuming this is correct, we will need to revise our assumption that the total velocity of a particle, given by the norm of a vector, is always c. Instead, we can assume that the total velocity of a particle is always 0, and that the velocity of the particle through this additional dimension is generally ic, where i is the square root of -1. For example, under this view, light would generally have a velocity of c through physical space, 0 through the state-space, and ic through this additional space, producing a total velocity of $||(c,0,ic)|| = 0$.

It seems plausible that this third space, if it exists, is time itself, and that all particles have a velocity through time, which could be a vector quantity. This would allow for the momentary emergence and disappearance of energy at small scales, which is consistent with observation. That is, energy comes and goes at small scales under this view because it is quite literally entering and leaving our timeline. Note that this does not pose any problems for the conservation of energy, since it is not the destruction of energy that underlies this mechanic, but instead, the transference of energy from one timeline to another. Moreover, there are no issues with causation so long as we assume that our timeline is a path through this space, where each point along the path represents a possible configuration of our universe. This would preclude any point in time “changing” another, since all points in time are, under this view, distinct configurations of the universe, none of which ever change at all. All particles that experience time jointly under this view would traverse the space of possible configurations of the universe with the same velocity, though what it is that is actually traversing this space is admittedly unclear. It could perhaps be thought of as an abstract, non-anthropomorphic “observer” particle, associated with every particle in physical space, that has some limited command, and perhaps in some cases no command, over its path through time.

We could even conceive of a “charge” in time itself. Specifically, a “force”, that makes certain future states more likely than others. Such a concept could explain the behavior of electrons, in that they are somehow able to find the path of least resistance, ex ante. This otherwise odd behavior could be explained by assuming that electrons are "attracted" to their own least resistant future states in time itself, making those future states more likely. As a result, this would allow electrons to alter their behavior in the presence of resistance, without having to “test” the resistance ex ante.

electrostatic forces. If repulsive gravity is in fact a physical reality, perhaps as generated by antimatter particles, then a black hole should eject antimatter particles, since they would presumably be repelled by the intense gravitational field of a black hole. Further, there could also be systems with repulsive gravitational fields that have points outside of their physical external boundaries where the probability of interaction is 1, forming a black hole for antimatter, and, presumably, a "jet" for ordinary matter that would be repelled.[8]

The Force-Carrier of a Magnetic Field

In a note entitled, *"Momentum, Magnetism, and Continuous Waves"* [3][9], we noted that a charge that is stationary in a magnetic field experiences no magnetic force. As a result, the probability of interaction at any point in a magnetic field depends upon the velocity of the charge, which is not the case for a gravitational or electrostatic field. Specifically, the probability of interaction is zero at every point in a magnetic field for a stationary charge. If the force-carrier of a magnetic field propagated at a non-zero velocity, then it would necessarily be the case that the probability of interaction would be greater than zero for at least one point in a magnetic field for a stationary charge, since eventually, a force-carrier would traverse some point in the field. Since this is not the case, it follows that the velocity of the force-carrier of the magnetic force is zero. Therefore, in our model, the force-carrier of the magnetic field is a type of stationary energy that does not appear to interact with light, or electrostatically neutral matter.

The frequency of a magnetic field will therefore also depend upon the velocity of a charge moving through the field. However, this does not imply that a magnetic field lacks objective structure. For this purpose, we can consider the **density** of a magnetic field in some volume of space, which we define as the number of magnetic force-carriers per unit of volume. The frequency of a magnetic field will therefore be a function of the density of the magnetic field, and the velocity of the charge traversing the field. For any given charge velocity, the frequency will increase as a function of the density of the magnetic field. Similarly, for any given magnetic field density, the frequency will increase as a function of the velocity of the charge.

If we assume that the density of a magnetic field is fixed, and uniform for all magnetic fields, then it would be the case that the strength of a magnetic field is determined entirely by the force per interaction Φ within the field, and that the frequency of a magnetic field would be determined entirely by the velocity of the charge. Under this assumption, Equation (2) implies that the force on a charge moving through a magnetic field will increase as a function of the velocity of the charge, and the strength of the magnetic field, which is indeed the case.

Matter as a Computational Engine

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[8] If the "big bang" was the result of an extremely massive antimatter black hole, then this could provide a simple explanation for the asymmetry between the amount of matter and antimatter in the universe, since a singularity of this sort would draw in antimatter, and eject ordinary matter.

[9] Available at https://www.researchgate.net/project/Information-Theory-16/update/5bce406b3843b006753fda45.

In [3], we presented a model of magnetic fields as being generated by the displacement of charges, and showed that our model is consistent with the Biot-Savart law. Specifically, if two charges are moving at the same velocity, then their relative positions are constant, and therefore, there is no displacement of the charges, implying that no magnetic field will be generated. This is consistent with the Biot-Savart law, since in that case, both charges would have a velocity of zero with respect to one another.

Now consider the net electrostatic field generated by two charges moving at the same velocity, and consider a point in space that is at a constant distance from both charges. Because the charges are both moving with the same velocity, this point in space will also move with that same velocity, though its position relative to both charges will be constant. If we assume that the net electrostatic field at the point in question is constant, then we can think of the net electrostatic field as constant as well, and simply moving through space with the same velocity as the two charges. That is, the net electrostatic field of the two charges can be thought of as a system itself that is co-moving with the charges.

Now consider the case where the two charges are not moving with the same velocity. Since the charges will be displaced with respect to one another, it follows that they will generate a magnetic field, which is again consistent with the Biot-Savart law, since the charges will have non-zero velocities with respect to one another. Further, the net electrostatic field generated by these two charges will change constantly as the two charges propagate through space, since their relative positions are not fixed, generating a dynamic net electrostatic field.

If we compare the computational complexity of these two cases, we see that the first case, where the charges are travelling at the same velocity, requires only that we update the position of a fixed, net electrostatic field, with no additional computation. In contrast, if we consider the second case, where the charges do not have the same velocity, we find instead a dynamic electrostatic field that will need to be constantly updated, adding significant computational complexity when compared to the first case. Also note that the first case does not generate a magnetic field, whereas the second case does.

In the model of mass that we presented in [1], the mass-energy of a particle served the role of a computational engine that "processes" the behavior of the particle. The more kinetic energy a particle has, the more of a "computational lag" the particle experiences, causing the particle to progress through its states at a slower rate, ultimately generating time-dilation. That is, in short, time-dilation can be viewed as the result of computational lag, as a particle struggles to process its own behavior as its kinetic energy increases. Because our model implies that the force-carrier of a magnetic field is stationary, we can take the view that the force-carrier of a magnetic field is actually a type of matter. Further, we argue that this "magnetic matter" functions as a computational "back-stop", allowing for the additional complexity of a dynamic electrostatic field generated by two displaced charges to be "processed". That is, magnetic matter arises out of necessity, in order to process the behaviors of a dynamic net electrostatic field, which in our model, consists of actual force-carrier particles that interact with each other, and exogenous charges.

If this theory of magnetic matter as a computational engine that processes the behavior of a dynamic electrostatic field is correct, then it should have an analog in the case of a gravitational field. That is, there should be some analogous mechanism by which dynamic gravitational fields generate sufficient computational complexity to necessitate the temporary emergence of an analogous type of matter. If we consider the case of a rotating mass, which would generate a dynamic gravitational field that would require constant updating, then perhaps we can explain the emergence of a centrifugal force as the result of some type of additional matter that arises temporarily to "process" the behaviors of the resultant gravitational field. That is, the centrifugal force is, under this theory, due to the temporary emergence of a type of matter that exists to process the added complexity of a dynamic gravitational field, just like magnetic matter is due to the temporary emergence of a type of matter that exists to process the added complexity of a dynamic electrostatic field. Whatever the characteristics of the matter that gives rise to the centrifugal force would be, it appears to interact through a force capable of repulsion.

In summary, under this theory, the mass-energy contained within a particle processes the particle's own behaviors, whereas some background matter processes interactions between force-carriers. When a particle's own computational resources are strained, it experiences time-dilation. In contrast, when the background matter's computational resources are strained, it seems that the momentum of the background matter increases, thereby increasing the force of interaction between the background matter and the particles with which it interacts. Under this hypothesis, this increase in momentum presumably corresponds to an increase in the "computational power" of the background matter, allowing the force carriers of the gravitational and electrostatic forces to always propagate at a velocity of c, regardless of the number and complexity of their interactions. That is, it seems that the interactions between the force-carriers of the gravitational and electrostatic forces occur instantaneously. This is in contrast to the interactions between light and a medium, which is known to cause the velocity of light to decrease.

Finally, we could assume that there is actually only one type of this stationary background matter that is always omnipresent and uniformly distributed throughout all of space, but that it is generally "dormant" in that it does not interact with particles in the absence of a magnetic or centrifugal force. We could then explain the emergence of the magnetic and centrifugal forces as the result of interactions with a single, omnipresent background field comprised of a type of uniformly distributed stationary matter that does not otherwise interact with mass, charge, or light.

Conservation of Energy and Momentum

The model of fields we presented above makes reconciling the assumption that energy and momentum are conserved, with the obvious accelerating power of fields, straightforward. Specifically, as noted above, we assume that acceleration in a gravitational, electrostatic, or magnetic field is always due to an interaction with a force-carrier particle. As a result, any energy or momentum gained or lost by a particle in a field, is always lost or gained, respectively, by the field itself through interactions between the particle and the force-carriers of the field.