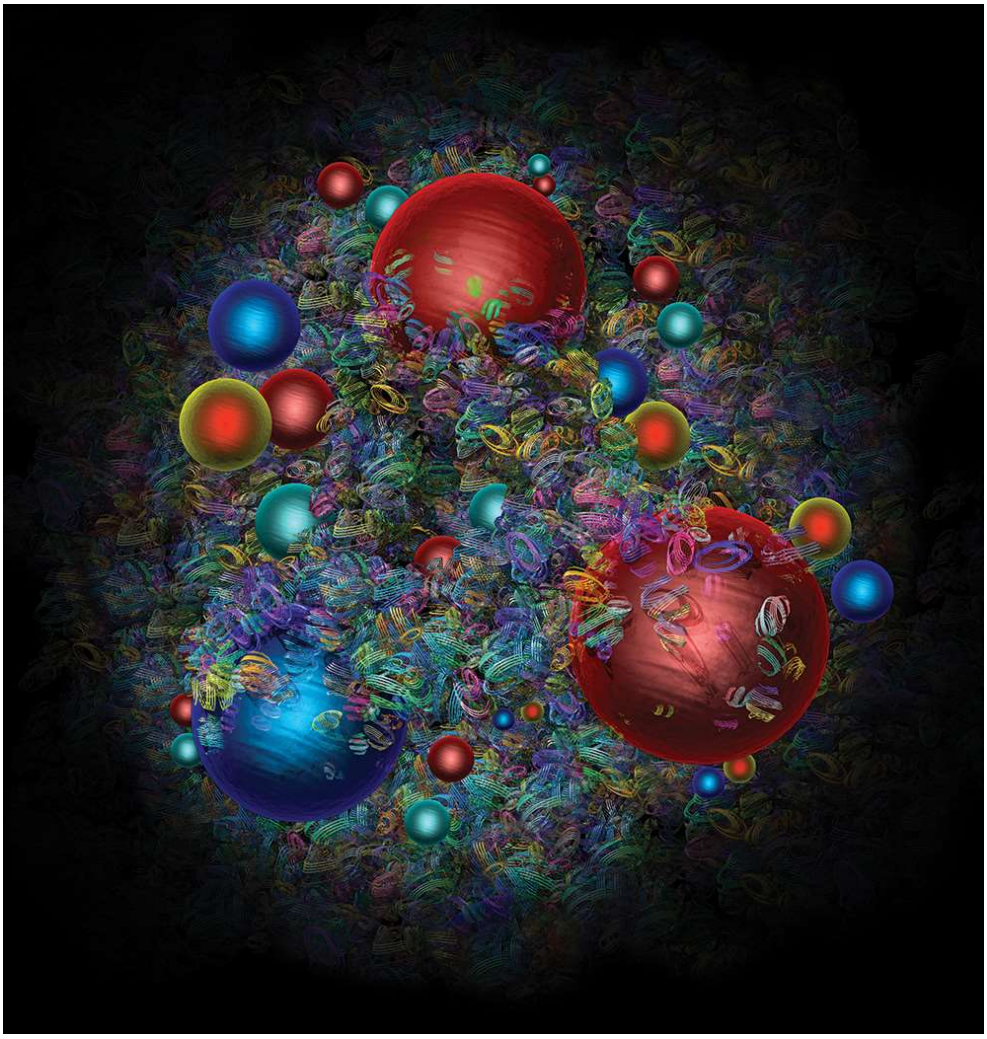
# An Examination of Gluon Field Excitation as the Initiating Cause of Time Dilation, Gravity and Dark Matter



Andrew B. Evans

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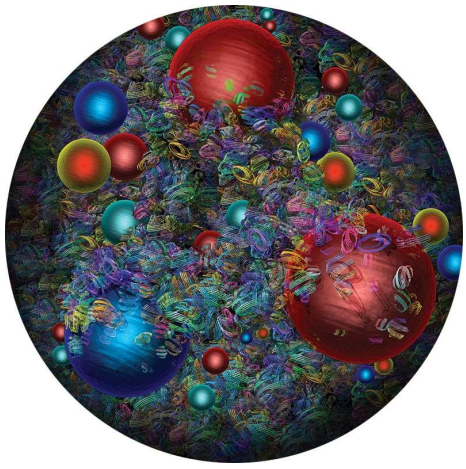
# An examination of gluon field excitation as the initiating cause of time dilation, gravity and dark matter Ver. 2.0

**Andrew B. Evans – January 31, 2022** ABEvans@shaw.ca

**Abstract**: Relying on known concepts of general relativity and quantum field theory, and using the Maxwell and Schwarzschild equations, this paper will investigate how charged gluon spin and subsequent excitation of the gluon field surrounding a gravitational mass result in the dilation of the particulate space of loop quantum gravity and the concurrent dilation of time; generally known as the warping of spacetime, which of course is gravity itself. This paper will also show that for any moving object the bow shock wave in the gluon field generates an analogous excitation of the field, thus leading to kinetic time dilation, gravity, and a new origin of dark matter. Furthermore, this paper will show that the gravitational behavior of a warped spacetime model based on a weather low pressure system is more appropriate than the commonly envisioned bowling ball in a trampoline. Finally, this paper will present a method of testing and proving the theory using frozen hydrogen, polarized with respect to the internal gluon spin.

**Introduction**: Theoretical Physicist John Wheeler provided a perfect explanation for the Einstein Equations when he said "Spacetime tells matter how to move, matter tells spacetime how to curve."[1] Since Einstein, we have known that gravity is not caused by an attraction between two bodies but rather by the warping of spacetime caused by a single body. Thus in our search for the underlying source of gravity we should be looking for an energy, emitted by a body, that results in this warping. This paper will provide a new explanation for the second half of Wheeler's statement and propose that the energy embedded in the gluon field is the cause of spacetime curvature leading to gravitational and kinetic time dilation, gravity and dark matter.

**Mass Number** is the driving characteristic of gravity, i.e. the number of subatomic particles of the element in question. A planet made of lead has a higher mass number, a higher number of subatomic particles (quarks, gluons and electrons) and stronger gravity than a similar sized planet made of tin. Thus it is not the size of the body that determines gravity; it is only the number of subatomic particles inside that body. Solomon made the statement that "mass is only a proxy for the amount of matter"[2]. All matter, regardless of size or density, gives rise to time dilation based on mass. For example the planet Earth has gravity. And if the Earth was blown to dust stretching across our solar system, it would still have the exact same level of gravity to a distant observer.[3] Thus we know that a random gluon field is not additive, analogous to a randomly spread bar magnet.

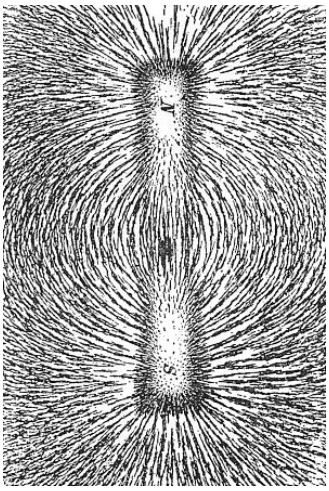


Depicting a single proton with a sea of quarks (red, blue and green spheres) and gluons (spring-like connections) popping in and out of existence and generating excitation of the gluon field.

The protons and neutrons that make up matter are themselves composed of elementary quarks and gluons. There are three valence quarks connected by gluons inside each nucleon, but there are also a very large number of "sea" quarks and gluons that continuously pop in and out of existence.

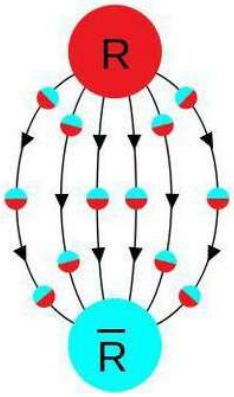
Why gluons? Quarks have mass and thus radiate a limited field. Gluons are massless exchange particles (vector gauge bosons with spin 1) for the strong force between quarks, analogous to the exchange of photons in the electromagnetic force between charged particles.[4] Although gluons are massless, they account for more than 99% of the total mass of the nucleon through mass/energy equivalence.[5] It is this very high level of energy that leads to the most energetic possible gluon field.

**Quantum Field Theory** tells us that space is not empty. It is filled with the quark and gluon fields of Quantum Chromodynamics (QCD), the quantum field theory of the strong interactions governing the structure of subatomic matter. Contrary to the concept of an empty vacuum, QCD induces chromo-electric and chromo-magnetic fields throughout space-time. It's reminiscent of the magnetic field that appears around a bar magnet in its lowest energy state.[6]



Energy of the electromagnetic field around a bar magnet

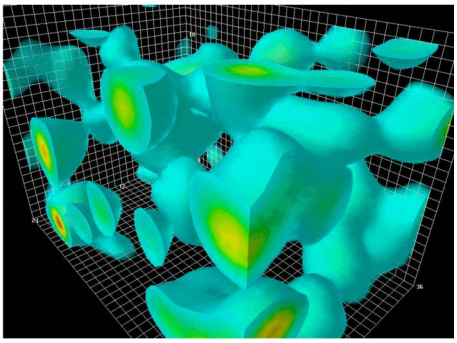
Subatomic particles such as electrons and gluons have the property of spin or angular momentum that can be described as a moving charge. Fields are created by this moving charge. For example a standard bar magnet functions because the composite atoms are aligned so all the internal free electrons are polarized to spin in the same direction to generate an additive magnetic field, made up of virtual photons as the exchange particles for the electromagnetic interaction. In quantum field theory, virtual particles are viewed as excitations of the underlying field, but appear only as forces – not as detectable particles[7]. Each individual atom in the universe is itself a tiny magnet with spin generating a tiny electric charge[8], but because each is spinning in random directions, the force is too small to be noticed. If one was to cut a bar magnet into many pieces and randomly spread these on a table, there would still be a magnetic field but it would have much less power than the field of the whole bar magnet because the free electron spin between pieces are no longer aligned.




Depiction of the gluon field

Gluons carry a color charge, analogous to the negative electrical charge carried by an electron. The spin of a gluon carries this color charge out into space surrounding a gravitational body. It is this charge, combined with the charge emanating from the gluons in the other $10^{50}$ atoms in a typical planet that generates the field excitation necessary to dilate particulate space and time.

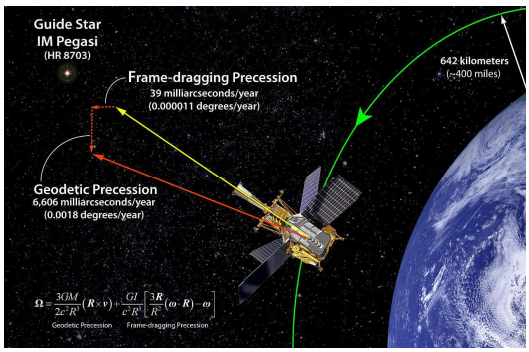
The gluon field for color charge has a time-like component[9] analogous to the electric potential or the amount of energy required to move a unit of charge from a reference point to a specific point in the electric field.[10] The gluon field is very similar to the electromagnetic field with the difference that, unlike the photons of electromagnetism, gluons carry charge and therefore interact with each other as well as with quarks.[11] Each gluon field also has three space-like components, analogous to magnetic vector potential that can be used to specify the electric field.[12] Thus the gluon field is a four-vector field that plays the same role in quantum chromodynamics as the electro-magnetic four-potential in quantum electrodynamics.



Topological charge density of the gluon field in empty space. This becomes much more active near a planet or star. Courtesy: D. Leinweber

Robert Kunzig said, "Like the photon that transmits the electromagnetic force, a gluon is massless. But unlike the photon, a gluon is charged. It generates its own color field, exerts its own strong force and interacts with other gluons. The color field, like the electromagnetic one, can be thought of as having two components, call them color electric and color magnetic. A fast-moving color charge (gluons move at c) generates a strong color magnetic field. Gluons are thus like little dipole magnets. The gluons that surround a quark align themselves parallel to its color field, they strengthen it. They antiscreen the quark, amplifying its field."[13]

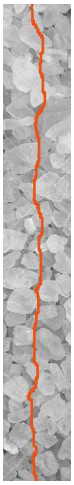
This falls squarely into the theories of gravito-electromagnetism,[14] (GEM) the set of analogies that allows us to make direct mathematical comparisons between Maxwell's equations for electromagnetism and the Einstein field equations for relativistic gravitation. The Gravity Probe B experiment[15] was strong evidence of the existence of a field surrounding Earth, and the concept of charged gluons generating this field becomes evident. According to GR, the gravitational field produced by a rotating planet can be described by equations with the same form as electromagnetism." That is, a magnet with polarized electron spin moving within a coil induces electric current. Bini et. al. confirmed the same principle holds for gravity; "we find that a special nonstationary metric in GEM can be employed to show explicitly that it is possible to introduce gravitational induction within GEM in close analogy with Faraday's law of induction and Lenz's law in electrodynamics."[16]




Gravity Probe B

We can state that a planet, with gluon spin, induces frame dragging in the gluon field surrounding the planet. We see that analogous to the magnetic field surrounding a bar magnet, there also exists a charged gluon field surrounding a planet or any other gravitational body. It is the movement of charged gluons, residing inside the protons and neutrons of the mass that generate this charged field.

Thus we understand that a moving gluon color charge is responsible for the energy of the gluon field surrounding a planet, analogous to the way spinning electron charge from the many pieces of a cut up magnet will energize the magnetic field around a table.



Light travels quickly around small particles and slowly around large particles.

**Introducing Loop Quantum Gravity.** The question becomes, exactly how does this excitation of the gluon field cause time dilation? I propose that this answer lies in particulate space and the theory of "loop quantum gravity". In this, space is made up of particles or loops, with each being extremely small, on the order of $10^{-35}$ metres. Physicist Carlo Rovelli, in describing them shaped as tetrahedra (a 3 dimensional triangle), noted, "The physics of quantum gravity is the physics of the quantum fields that build up

spacetime… A region of space can be described by a set of interconnected grains of space… The length of these links is determined by the field itself because geometry is determined by gravity."[17] Likewise, physicist Jim Baggott noted "LQG suggested that at the Planck scale, space is discrete, composed of individual units or quanta – the loops themselves. These represent the building blocks of space, which is formed from a weave, but more like chain mail produced by linking individual loops of steel than linen produced by weaving continuous threads. This kind of model suggests that space cannot be continuously variable. At the Planck scale, there must be some kind of ultimate area or volume which cannot be transcended. There can be no area smaller than the smallest area; no volume smaller than the smallest volume."[18]

**Permeability and Permittivity.** What I have done with the present hypothesis is to reverse the chicken and the egg from these concepts. It occurred to me that in a different universe, if the size of a space particle was larger or smaller, then the speed of light would itself be slower or faster. This works directly in conjunction with Maxwell's equations with $c = 1/\sqrt{\mu_o \varepsilon_o}$. That is, c is inversely proportional to the permeability and permittivity of free space. In this formula, $\varepsilon_0$ ($8.8542 \times 10^{-12}$) is the permittivity of free space. This can be thought of as the resistance of free space to the formation of fields, or the viscosity of space.

Paraphrasing from Arvin Ash; Why are $\mu_0$ and $\varepsilon_0$ these exact values? These are the constants of nature. These are properties of free space that tell us how fast magnetic fields and electric fields can interact with each other. This sets a limit on how fast these fields can propagate through space. In a different substance, or in a different universe, these constants could be different.[19] Thus if $\varepsilon_0$, the permittivity of space was lower, c would increase. Likewise if $\varepsilon_0$ was larger, as with the dilation of particulate space, c would decrease as we see with time dilation in gravity. Paraphrasing from Review of the Universe, "Just as space is defined by a network's discrete geometry, time is defined by the sequence of distinct moves that rearrange the network. Time flows not like a river but like the ticking of a clock, with "ticks" that are about as long as the Planck time: $10^{-43}$ second. Or, more precisely, time in the universe flows by the ticking of innumerable clocks - in a sense, at every location in the network where a quantum "move" takes place, a clock at that location has ticked once."[20]

To show approximations on how this works in a gravitational field, we compare the permittivity of free space against the permittivity of space on the surface of the gravitational body:

- In Free Space: $c = 1/\sqrt{\mu_o \varepsilon_o}$, where $\mu_0$=1.25663706 x $10^{-6}$ and $\varepsilon_0$=8.85418782 x $10^{-12}$
- And using the Schwarzschild metric to determine time dilation relative to free space: $t' = t/\sqrt{1 - 2Gm/rc^2}$

On the Earth: Mass=5.9722x$10^{24}$kg Radius=6.371x$10^{6}$m
We find a time dilation factor of $t_E$=1.000,000,000,699,68
c x $t_E$ – c = 0.21
Thus we find a permittivity factor of $\varepsilon_E = \varepsilon_0 \times t_E$=8.85418783x$10^{-12}$ or a difference of 21 centimeters per second in the relative speed of light versus free space.

On the Sun: Mass=1.989x$10^{30}$kg Radius=6.9634x$10^{8}$m
We find a time dilation factor of $t_S$ =1.000,002,121,041,69
c x $t_S$ – c = 636
Thus we find a permittivity factor of $\varepsilon_S = \varepsilon_0 \times t_S$=8.85420660x$10^{-12}$ or a difference of 636 metres per second in the relative speed of light versus free space.

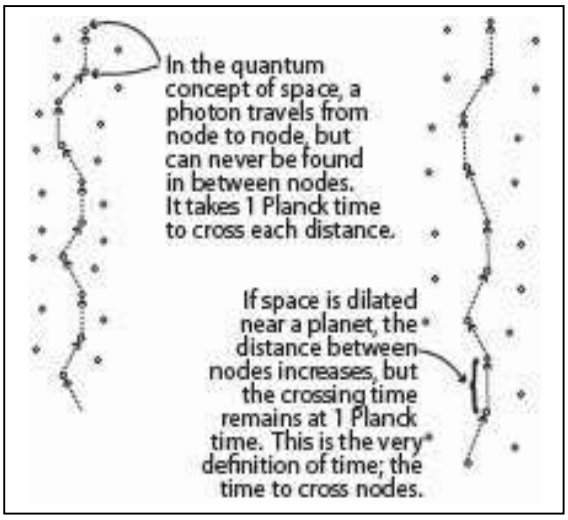
On star R136a1: Mass=$6.263 \times 10^{32}$kg Radius=$2.089 \times 10^{10}$m
(The largest known star) We find a time dilation factor of $t_R$ =1.000,022,265,004,83
$c \times t_R - c = 6675$

Thus we find a permittivity factor of $\varepsilon_R = \varepsilon_0 \times t_R = 8.85438498 \times 10^{-12}$ or a difference of 6,675 metres per second in the relative speed of light versus free space.

Thus we can see the extremely small distortion of spacetime surrounding Earth when compared to the larger distortion around the Sun and much large distortion surrounding star R136a1.

Of course we must not think of particles of space as hard physical objects, like grains of sand, in the same way that we must not think of an electron as a tiny moon orbiting a nucleus planet. For descriptive purposes, the nature of this has been imagined as a connection of rings like chainmail; or as a foam like soap bubbles, or as nodes like rocks in a stream, or as three dimensional tetrahedra. Any particle is nothing more than a vibration or an excitation of the underlying field. Particulate space, as defined in loop quantum gravity, is not in space but rather is that underlying field.

Dr. Don Lincoln from Fermilab said "When you add mass and energy, you can distort the shape of the little volumes of quantum space… Bending space and time has a property that you can distort the local definition of space."[21] Likewise Arvin Ash noted "How do particles traverse this quantized space? When mass and energy are added to the spin foam the shape of the volumes of the spin network is distorted. This distorts space and time… This distortion of space and time is what we perceive as gravity."[22]




We are left to conclude that the added energy of the gluon field surrounding a gravitational body causes a dilation, or swelling, of particulate space and subsequent time dilation. This becomes a clear definition of the warping of spacetime (and an understanding of the second half of Wheeler's statement) as used throughout relativity; it defines exactly how matter tells spacetime how to curve.

In a different way to envision this process in loop quantum gravity, we can speak of a photon traveling along a path of nodes in space like a man walking across scattered rocks in a river. These nodes define the quantum nature of space in that a photon can only move instantly from node to node but can never be found in between two nodes. The travel time from node to node is defined as the minimum possible tick of the quantum clock, i.e. 1 Planck time. If, near a planet, space is dilated by an excitation of the gluon field, then the distance between these nodes is increased and it takes longer (in relative terms) for a photon to cross that difference. But the travel period remains defined as 1 Planck time. Referring to Carlo Rovelli, "The central physical result obtained from loop quantum gravity is the evidence for a physical quantum discreteness of space at the Planck scale."[23]

**Why is time dilation a reasonable cause of gravity?** The answer is based on the third law of thermodynamics that all matter tends towards entropy. As an interpretation of this, we can say that in order to increase entropy, all matter wants to give up energy.

In his famous lecture, Nobel Lauriat Kip Thorne referred to what he calls "Einstein's Law of Time Warps". He said, "Things like to live where they age the most slowly. Gravity pulls them there. And so as an application, the Earth's mass warps time according to Einstein. It slows time near the surface of the Earth. And this time warp is what produces gravity."[24] This might also be related to the principle of least action, whereby any moving object will take the route that requires the least energy.

Thorn showed that mathematically the amount of time dilation required to produce the gravity we see on earth versus a height of 10,000km is one second per century. Recently, a rocket containing atomic clocks was sent to 10,000km and verified this estimate with great precision. Thus the tie between time dilation and gravitational potential is confirmed.

This testing also shows why gravity is such a weak force on Earth. It is the rate of time dilation that gives rise to the force. Thus, time dilation of only 1 second per century over a distance of 10,000km is very small. Near the sun, time dilation is greater and gravity is greater, and much greater still near a very large star, where the force of gravity is much stronger.

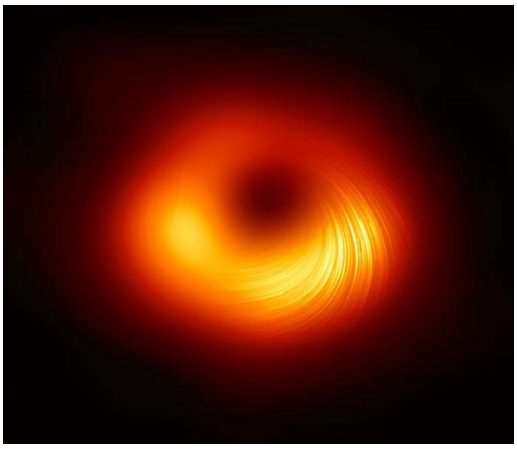
It is clear that a region of space where time has greater dilation (i.e. where time runs slower) has less energy than a region with less dilation. Thus any object and will achieve greater entropy by moving into a region of lower energy (greater dilation). This is what we call gravity.

**Gluons and gravity in the big bang period.** A recent study from the University of Copenhagen has investigated the state of the universe in the shortest possible time after the big bang.[25] They determined that the universe was made up solely of a quark-gluon plasma during the first 0.000001 second of the big bang. Associate Professor You Zhou stated "We have studied a substance called a quark-gluon plasma that was the only matter during the first microsecond of the Big Bang." It was only later that hadrons were formed by the combination of quarks and gluons.

It is also known that gravity predates matter. Jacob Brun noted: "It is at this stage after $10^{-43}$ seconds that the effects of gravitational interactions become distinguishable from electronuclear interactions and have a describable effect on spacetime. Interestingly enough, gravitation existed before matter did, and therefore, before mass. As what actually manipulates space-time is energy and its propagation through space. It is only when the strong force became distinguishable from the electroweak that we started seeing objects that could be described as "particles," and eventually matter, once electromagnetism separated from weak interaction."[26]

Thus we have confirmation that the only possible initiating source of time dilation and gravity must be either quarks or gluons, and as discussed above, gluons become the logical choice.

**Black Holes** offer a special situation but with the same cause and effect. A black hole initiates when a star collapses into a singularity. Understanding the Pauli Exclusion Principle, we realize that two or more fermions (1/2 spin particles such as quarks or electrons) cannot simultaneously occupy the same quantum state within a quantum system.[27] Thus, as a star collapses to a singularity, these particles must transform into energy that exits the rapidly forming black hole. This agrees with physicist John Wheeler (who coined the term Black Hole) who believed an imploding star converts its nucleons (protons and neutrons) into radiation during black hole formation.[28] Likewise, nothing with mass can reach c, so it would be impossible for a quark, with mass, to cross the distance between the even horizon and the singularity at the centre of a black hole.



Polarization of light is evidence of a magnetic field surrounding the black hole in galaxy M87. Courtesy Scientific American

However, bosons (spin 1 particles such as gluons) can occupy the same quantum state without limit. Therefore, when a star collapses all that remains of the original star are the gluons, compacted down into the singularity. Analogous to the example of the Earth being blown to dust, to a distant observer a black hole has the same level of gravity as the original star. Gluons are neither added nor subtracted during the collapse. We can arrive at a new definition of a black hole singularity – a star's worth of gluons captured in a single point.

Further evidence of the gluon field theory was confirmed with the discovery of polarized light surrounding a black hole, indicative of strong magnetic fields.[29] Although nothing can escape a black hole, the black hole can generate a very strong surrounding field such as an electromagnetic field or the strong gluon field of this paper.

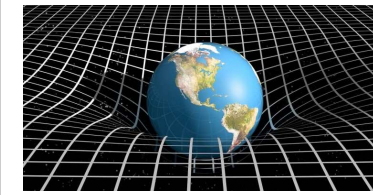
How does the proposed excitation of the gluon field escape from a black hole? Paraphrasing from Dr. Matt O'Dowd will provide the complete explanation.[30] "Virtual particles do not really travel from one location to another carrying force with them; they are not localized in that manner. If two electrons travel close to each other, they interact by the exchange of a virtual photon, or more preciously they exchange the sum of all possible virtual photons. Those photons don't follow a well-defined path between the electrons; they emerge from the electromagnetic field in the broader region occupied by both electrons." In the case of a black hole, gluon field excitation does not emerge from the singularity, and this force doesn't have to travel through the event horizon. The field surrounding the black hole is already "abuzz" with the virtual particles, whether that be the photons of the image above, or gluons of this thesis.

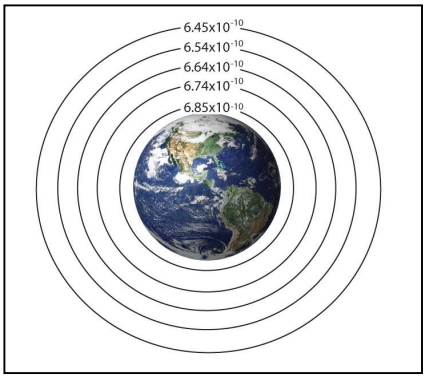
Nobel Prize winner Kip Thorne has provided more evidence of the present theory in his book Black Holes and Time Warps[31]. In describing a black hole, "Quantum gravity then radically changes the character of spacetime. It ruptures the unification of space and time. It unglues space and time from each other, and then destroys time as a concept and destroys the definiteness of space. Time ceases to exist; no longer can we say that "this thing happens before that one," because without time, there is no concept of before or after. Space, the sole remaining remnant of what was once a unified spacetime, becomes a random, probabilistic froth, like soapsuds."

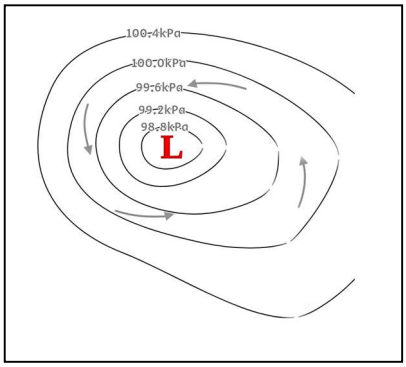
This would be an apt description of a black hole in the present theory. Inside the event horizon, time has completely stopped; particulate space has dilated to the extent that light can no longer cross between nodes. However, there is no reason why particulate space would not continue to dilate all the way down to the singularity at the centre of the black hole. Time and space have separated, exactly as Thorne described.

This description of a black hole provides further evidence of the general theory of this paper, that gluon color charge and spin are the initiating cause of gravity. Since there is nothing else remaining inside a black hole singularity, we are left with the sole choice of gluons.

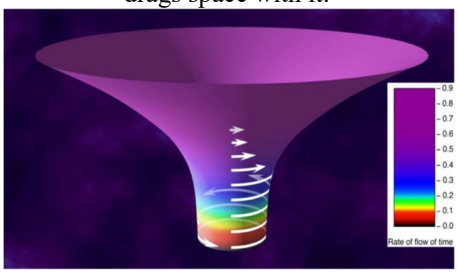
**Gravity as a low-pressure system:** The first half of Wheeler's statement; "Spacetime tells matter how to move," also requires an explanation. One might ask, why do objects always fall in one direction in curved spacetime, or why don't objects fall up? The answer comes when we realize that gravity works exactly like a weather low pressure system rather than the frequently used bowling ball in a trampoline model of warped spacetime. In a low-pressure system, wind circulates around and towards the centre of the Low. This could be referred to as frame dragging. If the wind travelled at c, it would not move in a circular way, but would simply travel straight into the centre. Since the Earth rotates at a high speed relative to wind speed, the wind must move towards the centre in a spiral fashion. Einstein proposed that the warping of spacetime is the cause of gravity. This low-pressure system model is simply a clearer definition of what physicists refer to as the geodesic in spacetime, as mathematically described with the Einstein Field Equations $G_{\mu\nu}+\Lambda g_{\mu\nu}=8\pi G T_{\mu\nu}$


Bowling ball in a trampoline model of spacetime



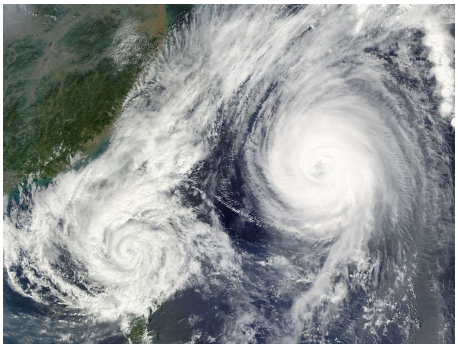




A rapidly spinning black hole drags space with it.

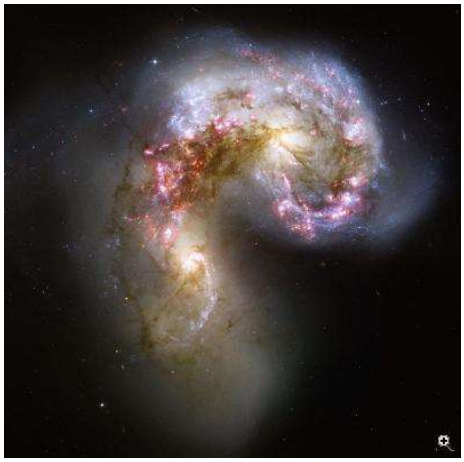



It has been shown with Gravity Probe B that gyroscopes in a satellite in Earth orbit move in a similar manner. They do not simply point down straight at the Earth's surface. Rather they are tilted slightly, reflecting that the rotation of the Earth is causing a slight dragging of space. Likewise a rapidly spinning black hole will drag space in a tight spiral. Physicists refer to this as Frame Dragging.

In a further similarity between gravity and a weather low pressure system, the Fujiwhara Effect describes when two tropical cyclones rotate around a common center of mass and merge. This is the same effect seen when two galaxies merge. Two cyclones can orbit around each other or merge in the same way that two galaxies merge.



Typhones Parma and Melor merging as described by the Fujiwhara Effect..



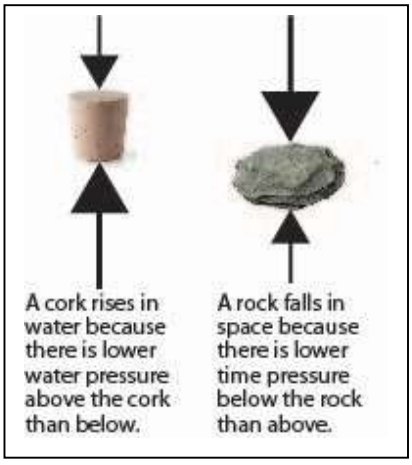
The Antennae Galaxies merging. The resemblance to two typhones merging is striking.

In yet another similarity between gravity and a weather low pressure system, we can look to a simple balloon on a string. If the balloon is carried from a high pressure to a low-pressure region, the balloon will expand such that the relative pressure between inside and outside the balloon remains constant. Likewise, if a clock is dropped from height, the time measured on that clock will itself dilate, in exact proportion to the time in space surrounding the clock.

We know that all objects, from a feather to an anvil, fall at the same speed and acceleration in a vacuum due to gravity. For a normal situation on a planet or star, this is because of the density of time through which they are falling. As an analogy, imagine three pieces of cork: 1kg, 10kg and 100kg and each is shaped so that they have the same resistance when dragged through water. Now imagine that we pull each piece under water so their centre of buoyance is at a depth of 100 metres. In exactly the same way as lifting the 10kg and 100kg corks up in the air would be more difficult than lifting the 1kg cork, pulling the larger corks down under water would be more difficult than pulling the smaller cork.

If the corks are released simultaneously, they would all rise to the surface with the same acceleration of 39.2 $m/s^2$. The only real resistance faced by the rising corks is the pressure of the water, which rapidly diminishes as the corks rise. All three corks will hit the surface at the same instant, exactly as if they had fallen from the sky. The buoyancy is due to the pressure above and below the cork. That is, the pressure of the water pushing down from above is lower than the pressure pushing up from below, so it rises.

We can pose the issue that although the three corks have different mass, they all have the same density relative to water and a different floating object will have a different relative density. Luckily, we can say the same about all matter when compared to spacetime; all matter, be it anvil or feather, have the same density when compared to time, i.e. c.




We can imagine a race of people living under the sea. They would see gravity where rocks fall to the sea floor with equal acceleration[32] and analogous anti-gravity where corks rise to the surface in with equal acceleration[33]. In both cases, it is not the characteristics of the rock or cork that establishes the gravitational or anti-gravitational acceleration. It is the

pressure of the medium above and below the rock or cork that creates the acceleration rate. I.e. it is the pressure of time above and below that establishes the rate for the falling rock and the pressure of water above and below that establishes the rate for the rising cork. The actual falling object has no importance in the process of the fall.

Bubble of air inside a sphere of water on the ISS. Courtesy U.S. Geological Survey

And through all of this we know that it is only the pressure that causes a buoyant object to rise. On the International Space Station, a bubble of air will remain trapped inside a surrounding sphere of water because the water pressure is constant in all directions.

Some[34] have proposed that the reason an object falls to Earth is because the high side of the object is running at faster time than the low side of the object, causing the object to curve downwards in its pathway through spacetime. This view is significantly misleading in that it assumes that only the object is subject to time dilation and not the space surrounding it. In fact time dilation within the falling object is irrelevant. Space itself is subject to time dilation and it is the gradient of time, in space that is why an object falls. An object falls because the space below it has lower time pressure than the space above it. As a further counter-example, light itself falls at exactly the same rate as an anvil or a feather, but light does not experience time. It cannot be said that the high side of the light is experiencing time at a faster rate than the low side. The gradient of time in the space above and below the light is the reason it falls.

The examples given above are very significant evidence of the similarity of time dilation/gravity to any other type of low-pressure system. If natural phenomena have very similar characteristics, it makes most sense to consider that they work in the same manner. Thus it is proposed that gravity caused by time dilation works in the same manner as a weather low pressure system. This does not detract from the warped spacetime concept of Einstein; it merely indicates that the low-pressure system is a better model than the bowling ball in a trampoline. At the same time, it does corroborate the idea that it is the relative density of time that becomes the cause of gravity.

One might ask whether it is the swelling of particles and the subsequent reduction in the density of space, that in itself becomes the source of gravity? This would be the situation inside the event horizon of a black hole where time dilation has reached its limit and time has stopped but space dilation continues down the singularity.

**Unification of Gravitational and Kinetic time dilation:** From the discussion above, we are led to understand that gravitational time dilation is caused by the energization of the gluon field near a gravitational body. Let us now look at kinetic time dilation from objects moving in space. We know from Einstein that as objects move faster, they experience time dilation with the formula:

$\Delta t = \Delta t_o / \sqrt{1 - v^2 / c^2}$ Where:

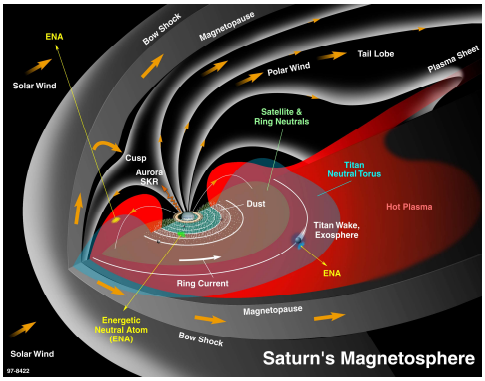
- $\Delta t$ = observer time (for example the time on Earth)
- $\Delta t_0$ = proper time (the time inside a fast moving rocket ship)
- v = velocity in m/s (velocity of the rocket ship, relative to the Earth)
- c = speed of light

Key to understanding the present theory of kinetic time dilation is that if a relativistic rocket passes very close to a clock on Earth, for the instant that the rocket was passing, the clock would

tick slower, matching the time dilation of the rocket itself. This indicates that it is not merely the fast moving object that experiences time dilation, but the region of space surrounding it as well.

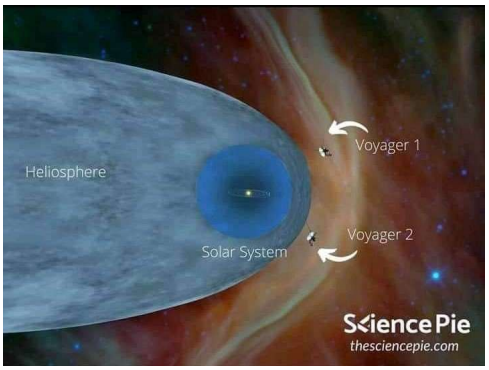
If we look at the analogy of a ship traveling in the water; the ship will create a bow wave, which is a wave of the water starting at the bow and moving back along the ship. This type of wave is true for any object moving through any liquid medium. It is just as true for a ship on the water or a jet in the air.

Martins[35], Arbab[36] and Ho[37] showed that the electromagnetic field behaves as an incompressible and irrotational, viscous fluid. There is no reason to believe that the gluon field would behave differently. Any object moving through space will generate a three-dimensional bow wave in the quantum field. This could be a rocket ship, a planet, solar system or galaxy. The faster and the larger that the object is moving in space, the larger will be the amplitude of the bow wave, leading to an energization of the field analogous to that created by the gluons inside a gravitational body, and hence to the subsequent dilation of particulate space and time dilation. There is no difference between the primary causes of kinetic or gravitational time dilation. They are both caused directly by an excitation of the gluon field. Only the origin of that excitation is different.




Bow shock wave - the outermost layer of Saturn's magnetosphere. Note the size of the bow wave compared to the planet. NASA.

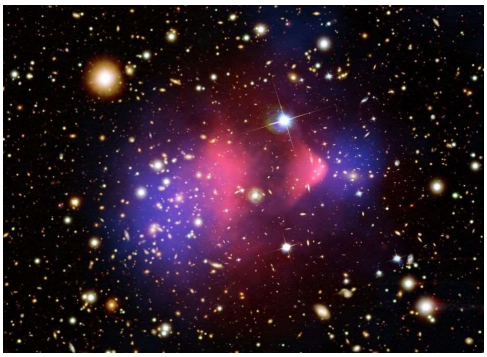
Of note is that in exactly the same way as it is impossible for any object with mass to reach c, it is impossible for a displacement ship travelling through the water to climb up and over its own bow wave (unless it moves up on plane and is thus no longer in the water medium.) This is known as the hull speed. As a ship moves faster it will build a higher and steeper bow wave, using an exponentially greater amount energy to travel slightly faster but never able to exceed its hull speed. This is analogous to a rocket moving faster through space when the bow wave becomes higher and steeper. It requires more and more energy for the rocket to continue accelerating, until the bow wave is vertical at c and further acceleration becomes impossible. Thus we can see how time dilation, velocity and the bow wave are all related.




Bow shock wave of our solar system.

**Dark Matter:** Dark matter is said to be unseeable matter that gives a strong gravitational pull on the surrounding space. Strong evidence of its existence was given with observations of the Bullet Cluster, in which two clusters of galaxies with a total mass of $2.5 \times 10^{14}$ solar masses are passing through each other at an incredible 10 million kilometers per hour (about 1% of c), with gas temperatures of 100 million degrees and creating a massive bow shock wave. (NASA is well aware of the bow shock wave generated by the Bullet Cluster.[38])

We understand that the physical body of the stars is only a minor contributor to this shock wave. Of much greater importance is the collective solar wind radiating at an additional 1.4 million kilometers per hour from all of the 2.5 x $10^{14}$ stars in the cluster. This is a well studied phenomenon with the 2018 Magnetospheric Multiscale (MMS) spacecraft experiments[39]. "The quasi-perpendicular forward shock that MMS observed is characterized by an extremely sharp ramp in the interplanetary magnetic field magnitude, the arrival of the shock-heated plasma downstream of the ramp, jumps in both flow speed and density, significant electric field fluctuations, and intense electromagnetic wave activity." These interplanetary shock waves are a type of collisionless shock where particles transfer energy through electromagnetic fields instead of bouncing into one another.



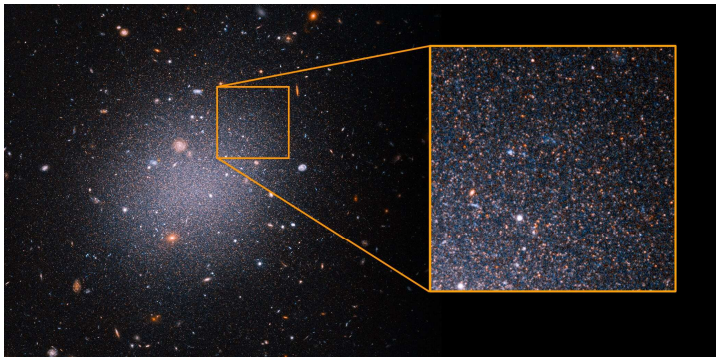
Gravitational lensing from the Bullet Cluster of 40 Galaxies in pink with dark gravity in blue. The resemblance to a bow wave is unmistakable.

In quantum field theory even a quantum field in the vacuum state (lowest energy or ground state) with no particles can become polarized if bombarded by charged particles. Ethan Siegal noted, "This doesn't mean that empty space is full of particles, but rather that you have quantum mechanical operators, including the "particle creation" and "particle annihilation" operators, acting on the quantum state continuously…. This phenomenon does have real, observable effects. One of them is known as vacuum birefringence: the notion that a strong, external field can cause this type of polarization – the creation of an internal field – to empty space itself."[40] Of course the solar wind from every star is a constant stream of charged particles which would have the effect of polarizing the gluon field caught within the bow shock wave of the moving galaxies. Analogous to how polarization of electron spin generates a stronger magnetic field, this polarization of the gluon field originating with the charged particles of solar wind creates a much more energetic gluon field than if just the physical stars were responsible for the bow wave and thus has a much larger impact on the dilation of particulate space and the subsequent dilation of time, and thus gravity. This is the reason why dark matter is such a strong force but remains invisible.

Rather than using the term "dark matter" I suggest that we should use "dark gravity", because it is not an issue of matter, but rather an issue of gravity. If we look at the bow wave concept above, we see that any object moving at a high speed will cause a bow wave and energization of the gluon field, then dilation of particulate space leading to time dilation and thus gravity. Hooft took this concept even further when he made the statement "Absence of matter no longer guarantees local flatness."[41] Moffat & Toth, in their Modified Theory of Gravity, postulated a "massive vector field" and a coupling constant that measures the coupling strength between that field and normal matter.[42] The bow wave concept agrees with these ideas and puts forth that it is only an excited gluon field that is required for time dilation and gravity.

Galaxies generally reside at the centers of vast clumps of dark matter called haloes. A recent study published in the Royal Astronomical Society monthly newsletter examined dark matter gravitational lensing surrounding 3200 galaxies.[43] It found that massive galaxies have more massive dark matter haloes, and for galaxies with similar mass, those that are more extended also have more massive dark matter haloes. A similar study found "a clear connection between the distribution of stars within massive galaxies and halo mass…. At fixed total stellar mass, massive galaxies with more extended mass distributions tend to live in more massive dark matter haloes."[44] The similarities between dark matter and the bow wave of a ship on the ocean are striking. Would the heliosphere of each star along with the massive amount of matter and gas in the Bullet Cluster, moving at this incredible speed, be sufficient to create the bow wave that generates the measured gravitational effect?

A map of dark matter superimposed over visible galaxies.



Ultra Diffuse Galaxy NGC1052-DF2 Credit NASA

Further evidence is provided by 2021 studies on the Ultra Diffuse Galaxies NGC1052-DF2[45] and AGC 114905[46] which found a lack of dark matter. These galaxies are the same size but with only 1% the mass of the Milky Way. It is logical that such a galaxy would generate a much smaller bow wave (or no bow wave at all) compared to galaxy with greater density. A group of row boats would not generate the same bow wave as an aircraft carrier.

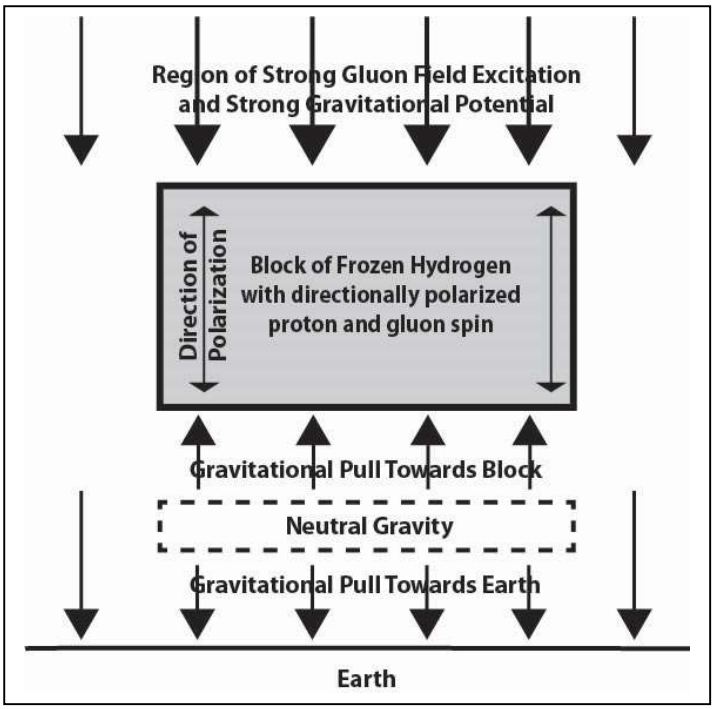
More evidence for this concept of dark matter as nothing other than a wave in the gluon field is provided with the fact that dark matter can not come together to form a planet, a star or a black hole.[47] Normal matter experiences electromagnetic interactions; dark matter does not. Also dark matter has no collisions, no friction, experiences no heating and no way to exchange energy or momentum with other particles – either normal or dark particles – that exist within a galaxy. Normal matter sheds linear momentum and angular momentum and sinks to the core of a galaxy where it forms individual, dense small-scale clumps. Whereas dark matter always remains diffusely distributed in an enormous halo around the galaxy – unable to shed linear or angular momentum. Without a mechanism to shed angular momentum, dark matter can never even approach the densities necessary to create an event horizon or black hole.

Still more evidence is provided in a 2022 study by Moreno et. al.[48] in which they identify that small galaxies which have passed through larger galaxies often have lost their dark matter halo. It is apparent that the solar wind proceeding these small galaxies, which is the source of gluon

field polarization under the present theory, would be stripped away by the gravitational attraction of the larger galaxies.

**Gravitational Waves**: Working further from the above concepts, it provides evidence of what makes up the recently confirmed gravitational waves[49]. The collision of two black holes would inevitably generate a significant wave in the gluon field. This wave would propagate across space, leading to a momentary expansion of particulate space as it passes. As described earlier, this leads to the momentary dilation of spacetime and thus gravity.

**Testing and Proof:** (patent pending[50]) A relatively simple means and method of testing this theory can be provided with polarized frozen hydrogen. Hydrogen freezes to a solid at a temperature of 14°K[51]. It has been shown by Ohata et al [52] that frozen hydrogen can be polarized with respect to internal proton spin by passing an electromagnet back and forth along the block of frozen hydrogen. Likewise, it has been theorized by de Florian et al[53] that polarized gluons make up the major proportion of polarized protons. Thus we can conclude that the act of polarizing protons within frozen hydrogen will result in a large proportion of polarized gluons. The present theory holds that polarized gluons will behave analogously to polarized electrons within a bar magnet. That is, they will cause a stronger excitation of the gluon field surrounding the frozen hydrogen. In the present theory, this in itself will lead to a dilation of particulate space surrounding the frozen hydrogen. This will become a localized gravitational field surrounding the hydrogen. Such a block of frozen hydrogen, if positioned above the Earth would generate a stronger gravitational field above the block and a weaker gravitational field and a region of neutral gravity (free floating) in between the block and the Earth. Thus proof of the present theory will be readily apparent.




**Conclusion:**

This paper has shown the strong causal relationship between gluon color charge, the excited gluon field, the particulate space of quantum loop gravity, time dilation and then gravity. Strong evidence for this concept is provided through the examples of the first second after the Big Bang and the singularities of a Black Hole. This paper has also shown the very close resemblance between a gravitational field and a weather low pressure system. Finally, this paper has provided a relatively simple means and method of testing and proof. We are thus left with a complete theory of spacetime, gravity and time dilation.

[1] NewScientist, General Relativity, https://www.newscientist.com/definition/general-relativity/

[2] The Origins of Gravitational Fields, B.T. Solomon & A.W. Beckwith, Journal of Space Exploration, January 25, 2017

[3] Shell theorem in Newtonian gravity (https://en.wikipedia.org/wiki/Shell_theorem) and Birkhoff's theorem in general relativity (https://en.wikipedia.org/wiki/Birkhoff%27s_theorem_(relativity))

[4] Gluon basic definition: https://en.wikipedia.org/wiki/Gluon

[5] Quantum chromodynamics binding energy – basic definition https://en.wikipedia.org/wiki/Quantum_chromodynamics_binding_energy

[6] Centre Vortices in the Gluon Field of the QCD Vacuum. CSSM Vistualization: https://www.youtube.com/watch?v=CDdmx989quA

[7] Wikipedia: Virtual Particle

[8] National Geographic – Magnetism https://www.nationalgeographic.org/encyclopedia/magnetism/

[9] Wikipedia: Gluon Field;

[10] Wikipedia: Electric Potential

[11] Gould, Christopher R., Encyclopedia of Physical Science and Technology, Third Edition, 2003

[12] Wikepedia: Magnetic Vector Potential

[13] The Glue That Holds the World Together, Robert Kunzig, June 30, 2000. Discover magazine

[14] Gravitoelectromagnetism – basic definition, https://en.wikipedia.org/wiki/Gravitoelectromagnetism

[15] Gravity Probe B – basic description https://en.wikipedia.org/wiki/Gravity_Probe_B

[16] Bini, Donato ; Cherubini, Christian; Chicone, Carmen; Mashhoon, Bahram; Gravitational Induction, arXiv: 0803.0390v2, November 8, 2008

[17] Carlo Rovelli, Covariant Loop Quantum Gravity, Nov 13, 2004

[18] Baggott, Jim, Quantum Space, Oxford University Press, 2018. P 171.

[19] Arvin Ash, Why is the speed of light what it is? Maxwell equations visualized. https://www.youtube.com/watch?v=FSEJ4YLXtt8

[20] Review of the Universe, Structures, Evolutions, Observations and Theories, http://universe-review.ca/R01-07-quantumfoam.htm

[21] Dr. Don Lincoln, Fermilab, Loop Quantum Gravity, 2018, https://www.youtube.com/watch?v=QMpkFde3euA

[22] Arvin Ash String Theory versus Loop Quantum Gravity, https://www.youtube.com/watch?v=3jKPJa-f3cQ&t=662s

[23] Carlo Rovelli, Loop Quantum Gravity, Living Reviews in Relativity, July 15, 2008

[24] Cornell University talk: 100 Years of Relativity: From the Big Bang to Black Holes, Gravitational Waves and 'Interstellar'

[25] You Zhou, Associate Professor, Neils Bohr Institute, University of Copenhagen, as cited in Phys.org, May 21, 2021 "Study reveals new details on what happened in the first microsecond of Big Bang.

[26] Jacob Bruns, M.S. Planetary Science & Astrophysics, University of Colorado, as cited in Quara, September 30, 2018. When did gravity first arise in the universe after the big bang? https://tinyurl.com/jatkr9ts

[27] Pauli Exclusion Principle – basic description; https://en.wikipedia.org/wiki/Pauli_exclusion_principle

[28] Thorne, Kip S. Black Holes and Time Warps, Einstein's Outrageous Legacy, W.R. Norton & Company PP 244-253

[29] Scientific American : Magnetic Field around a Black Hole Mapped for the First Time - Scientific American Stephanie Pappas, March 24, 2021

[30] O'Dowd, Matt: PBS Spacetime: How Does Gravity Escape a Black Hole, January 27, 2022

[31] Thorne, Kip, Black Holes and Time Warps – Einstein's Outrageous Legacy, Page 476

[32] Gravitational Acceleration – basic description; https://en.wikipedia.org/wiki/Gravitational_acceleration

[33] Acceleration due to buoyancy and mass renormalization, McGee & Czarnecki, University of Alberta, Jan 3, 2019

[34] PBS Space Time: Does Time Cause Gravity, https://www.youtube.com/watch?v=UKxQTvqcpSg

[35] Martins, Alexandra; Fluidic Electrodynamics, on parallels between electromagnetic and fluidic inertia, Institute for Plasma and Nuclear Fusion, Portugal, 2012

[36] Arbab, A.I., "Is the electromagnetic field in a medium a fluid or a wave?" Department of Physics, Qassim University, September 2016

[37] Ho, V.B., "Fluid State of the Electromagnetic Field", Advanced Study, Victoria, Australia

[38] NASA Science Casts: Cosmic Bow Shocks, EarthSky.org: Nature Likes to Make Bow Waves, March 13, 2018

[39] Cohen, I.J., Schwartz, S.J., Goodrich, K.A., Ahmadi, N., Ergun, R.E., Fuselier, SA et al; High-resolution measurements of the cross-shock potential, ion reflection, and electron heating at an interplanetary shock by MMS, Journal of Geophysical Research: Space Physics, 124 3961-3978

[40] Siegal, Ethan: "Ask Ethan: Do Virtual Particles Really Exist?" Starts with a bang May 7, 2021

[41] A Locally Finite Model for Gravity, Hooft, G, Institute for Theoretical Physics, April 2008

[42] Moffat, John W & Toth, Viktor T, Cosmological Observations in a Modified Theory of Gravity, Perimeter Institute for Theoretical Physics, May, 2013

[43] Science Daily: Seeing Dark Matter in a New Light, 6 November,2020
www.sciencedaily.com/releases/2020/11/201106093016.htm

[44] Royal Astronomical Society, Monthly Notices, December 5, 2019. Weak lending reveals a tight connection between dark matter halo mass and the distribution of stellar mass in massive galaxies.

[45] Hubble data confirms galaxies lacking dark matter, June 17, 2021, Lee Sandberg, Institute for Advanced Study, Phys.org As published in Astrophysical Journal Letters, June 9, 2021

[46] Sanchez, Kait: Scientists Baffled by a Galaxy's Missing Dark Matter: ign.com December 26, 2021

[47] Siegal, Ethan, "Ask Ethan: Why can't Black Holes be made of dark matter?: Starts with a Bang, November 12, 2021

[48] Jorge Moreno, Shany Danieli, James S. Bullock, Robert Feldmann, Philip F. Hopkins, Onur Catmabacak, Alexander Gurvich, Alexandres Lazar, Courtney Klein, Cameron B. Hummels, Zachary Hafen, Francisco J. Mercado, Sijie Yu, Fangzhou Jiang, Coral Wheeler, Andrew Wetzel, Daniel Angles-Alcazar, Michael Boylan-Kolchin, Eliot Quataert, Claude-Andre Faucher-Giguere, Dusan Keres, Galaxies lacking dark matter produced by close encounters in a cosmological simulation, https://arxiv.org/abs/2202.05836

[49] Scientists make first direct detection of gravitational waves, MIT News, MIT.edu

[50] Patent Application, USPTO, September 27, 2021: Gravitational Field Generator and Method to Generate a Localized Gravitational Field, Andrew B. Evans. Application Number 17486030

[51] Solid Hydrogen: Wikipedia https://en.wikipedia.org/wiki/Solid_hydrogen

[52] Monitoring the build-up of hydrogen polarization for polarized Hydrogen-Deuteride (HD) targets with NMR at 17 tesla; T.Ohta, M.Fujiwara, T.Hotta, I.Ide, K.Ishizaki, H.Kohri, Y.Yanai, M.Yosoi, Research Center for Nuclear Physics, Osaka, Japan
Spinning Gluons in the Proton, Steven D. Bass, Marian Smoluchowski Institute of Physics, Jagiellonian University, Krakow, Poland, March 6, 2017

[53] Evidence for Polarization of Gluons in the Proton; Daniel de Florian, Rodolfo Sassot, Marco Stratmann, and Werner Vogelsang, Phys. Rev. Lett. 113, 012001 – Published 2 July 2014