A Beginner's Guide to a New Understanding of Gravity

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A new understanding of gravity is presented. It ascribes gravitational attraction to a loss of stored energy (mass) as an object moves closer to other massive bodies. It is simply conservation of energy with a decrease in the object's mass being released as kinetic energy of motion. It does not require an increase in the distortion of space to match that in time due to the change in energy. The new perspective challenges the current consensus model of cosmology. The gravitational redshift of distant galaxies is not a Doppler shift due to recession speed or an expansion of the scale of empty space. It simply reflects the lower energy held by matter going back in time when the speed of light was faster. This removes the need for an initial big bang, cosmic inflation, dark matter and dark energy. It is shown that a space and time that are each malleable according to the location and movement of the observer but linked via an invariant speed of light is an illusion. An underlying reality exists independent of the observer. Gravity is not a warping of spacetime. However, the revised theory, Full Relativity, can still reproduce the many apparent successes of Special and General Relativity. It already has had success in explaining and removing unexpected observations such as dark energy, the Hubble tension and the horizon and flatness problems. Further tests are proposed.

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10th July, 2025

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Introduction

Einstein's General Relativity has reigned as the accepted theory of gravity for more than 100 years. This theory claims that gravity is an invisible distortion of a fabric of spacetime by matter and energy. Thus, it proposes that gravity is not a real force. Instead, massive objects follow the shortest path in the curved geometry of space and time. The planets moving around the Sun just follow the curved spacetime. However, we cannot "see" this distortion, except indirectly in terms of the change in how fast clocks tick and the small amount that massless light is bent when it passes close to the Sun.

This theory, and its' claimed repeated "proof" by observations, is being called into question.

A new, radically different, but simpler understanding of gravity is being proposed. It challenges key aspects of Relativity. It is based on revised perspectives on the relation between distance and time, between mass and energy, and on the nature of the background field that determines both light and particle properties as well as gravity's action-at-a-distance. It resolves the inconsistency between General Relativity and Quantum Mechanics, and allows gravity to be consistent with the Higgs mechanism of the Standard Model of particle physics. It thus provides a path towards the unification of all four fundamental forces. In passing, it removes the singularities inside black holes, removes the problem that opposite sides of the universe from us are too far apart to have ever been in equilibrium, and removes the fine-tuning problem of General Relativity. Under the latter, the Euclidean flatness (lack of curvature) of the universe should happen just once; which happens to be now, when we are here to see it! It also removes the need for dark energy while predicting that an apparent accelerating expansion, of the observed amount, should occur because of the faulty assumptions made. It also appears able to remove the invisible dark matter that is not expected within the Standard Model, the Hubble tension, and the need for a big bang. Finally, it appears to reproduce all the evidence seeming to confirm the predictions of General Relativity.

These claims appear enormous but the reasoning is fairly straightforward. However, it requires a careful step by step journey through the assumptions, derivations and alternative hypotheses. It begins by demonstrating that mass is just the energy stored in an object at rest. Or, more precisely, it is the momentum trapped at a mean location. The swinging of a pendulum under gravity is nothing more than the release of some of its mass (stored energy) as kinetic energy of motion, followed by the energy being restored to the object from the work done against the gradient in gravitational potential. However, this simple change in perspective has dramatic consequences beginning with the mass of the same matter being variable, as well as the speed of light. These and many others issues, particularly an understanding of how a background field can give rise to wave/particles and observed behaviour, need to be explored. Ultimately, these considerations lead to proposed mechanisms.

Accepting such changes, also has to be interleaved with an understanding of how and why Relativity arose and where there were faulty steps and alternate hypotheses that went undetected. The details, including the conflict with an underlying reality, have been relegated to Appendices. It must also be shown how and why the many predictions of General Relativity can be reproduced and key problems overcome. This takes time and may require some additional background study. The reader is therefore, asked to have patience. The critical evaluation of the new theory may then suggest better and further experimental and observational tests, further consequences, or new directions.

Relativity and spacetime

The fabric of the cosmos – spacetime – first arose from Einstein's theory of Special Relativity. This theory sought to explain why motion at constant speed <u>seemed</u> to have no discernible effect on the behaviour we observe. This tied in with the unexpected result of Michelson-Morley interferometer measurements which could not detect any change in the speed of light with the change in the Earth's direction of motion in its orbit. Maxwell's equations had indicated that a changing electric field could induce a changing magnetic field and the oscillation between these fields was calculated to travel at the known speed of light. It was assumed that a medium or aether was needed to carry not only light waves but all electromagnetic fields. However, it appeared impossible to tell how fast the Earth was moving relative to the background medium (aether) that carried light.

Length contraction was postulated by George FitzGerald (1889) and Hendrik Antoon Lorentz (1892). It was claimed that a moving observer would see the length of a stationary rod contracted by the factor γ (where $\gamma = 1/\sqrt{1-v^2/c^2}$). According to Bohm [1] this was based on Lorentz's analysis of the effect on electrons in the field of atoms when a crystal was moving relative to the aether. Subsequently, Lorentz added a time variable, the "local time". Motion relative to the aether would increase the time taken for light to traverse the longer path perpendicular to the motion through the aether. The length contraction was then matched by a dilation (slowing) of time that kept the observed speed of light constant for all observers. It was as if the arms of the Michelson-Morley interferometers were shortened but the time for light to propagate was slowed so that absolute movement relative to any background could not be detected.

This Lorentz transformation (LT) converted distances and times between moving and stationary observers, and it was shown that the transformation left Maxwell's equations of electrodynamics unchanged.

The speed of light is observed to be independent of the speed of movement of the emitting source. This is now well established by the observation that we can deduce the orbits of distant binary stars without correcting for their speed of movement. If movement reduced the light-speed towards us when a star was moving away then it would be overtaken by light emitted later in the orbit when it was moving towards us. No such effect has been observed. Other relevant observations were that the negative aether drift experiments seemed to establish that there was no preferred reference frame, and did not allow the dragging of the aether by the object to explain the results. It had also been observed that electrons became more difficult to bend (by γ) with speed.

The wider context in which Einstein developed Special Relativity has been set out elsewhere [2]. As a youth, he had argued that if an observer travelled at the speed of light then the oscillations between electric and magnetic fields would stop and light would no longer exist. Hence, he was open to the idea that light must always travel at this speed independent of motion relative to anything. In his 1905 paper he argued that the independence of electromagnetic induction on whether it is the magnet or conductor that is moving established that, for electromagnetism, only relative motion is relevant [3]. He noted the constancy of the speed of light and that, in an enclosed space, it did not seem possible to sense movement at a constant velocity. He used this information to deduce the LT. He therefore proposed that what was true for electromagnetism and optics was also true for mechanics and dynamics. Hence, physical laws were independent of the speed of motion relative to anything. He argued that, in the absence of gravity, the space and time that the observer perceived depended on relative movement but the speed of light was fixed for all observers. Time was dilated and space was contracted by relative motion.

Minkowski, subsequently put Lorentz's and Einstein's ideas into a formulation of invariant intervals of a linked space and time (spacetime) that had space expanded and distances contracted by relative motion [4].

Special Relativity applies to movement at constant velocity. Einstein wanted to extend the ideas to accelerated motion. After 10 years of struggle, he built on the observation that gravity appeared to be transformed away for an observer in free-fall. He then argued that, since all bodies accelerate in the same way, an observer in a freely falling laboratory will not be able to detect any gravitational effect (on a point particle) in such a frame – the Equivalence Principle. It led to gravitational acceleration being attributed to a curved spacetime. Its geometry could be distorted by relative gravitational potential and, more generally, by energy and momentum. This concept of a malleable and subjective linkage of empty **space**, the distance between objects not in relative motion, linked to a subjective time that together give a constant light-speed is rejected. Spacetime will be shown to be an illusion. The development of Special and General Relativity is set out more fully in Appendix A, along with examinations of the hypotheses, assumptions and mathematics of their derivations.

Mass, energy and gravitational potential

When you lift an object above your head, further from the floor and further from the massive Earth, into a region of lower density from the mass of other objects, you are doing work. There is a change in the potential energy of the object equal to the work – force by distance – that you expend in overcoming the force of gravity. Where is that energy? The standard answer is unedifying: "it goes into gravitational potential energy". A potential energy being one that depends on relative position or location. For example, the potential energy of a spring depends on how much it is stretched. But what is "stretched" by gravity? Where is it hiding? We need to work out how and where that energy is held.

A swinging pendulum has no energy of motion when it is momentarily stationary at the top of its swing. It then loses potential energy until, at the lowest point, the kinetic energy of the bob is at a maximum and its potential is at a minimum. The difference in potential energy has been converted into kinetic energy of motion. On the upward swing, the work done in lifting the mass (of the bob) higher, the integral of the vertical force over the change in height, restores the potential. This gravitational potential is the energy gained by a given quantity of mass with location. It is a remarkable property of matter. According to Newton's law of gravitation, mass determines how strongly every type of matter is attracted by gravity. However, it is not the same as weight. It also determines how difficult it is to accelerate (change the direction or speed of movement of the same matter) independent of the strength of gravity. The difficulty of accelerating objects on a frictionless, horizontal table is independent of gravity. Similarly, any two objects crashing into each other at the same relative speed, get as badly damaged whether it happens on the Earth, the Moon, or in space.

Mass is stored energy

How can this property we call mass be understood? Einstein came up with an answer in 1905 when he derived $E_0 = mc^2$: "*The mass of a body is a measure of its energy content*" [3]. He later observed that: "*Mass and energy are therefore essentially alike; they are only different expressions for the same thing. The mass of a body is not a constant; it varies with changes in its energy*" [5]. The conclusion is that mass is energy stored in a body at rest (hence the subscript zero).

This idea ties in with chemistry and the observation that the masses of different atoms, their atomic weights, vary according to their binding energy. The mass of a helium atom is less than the total mass of two hydrogen atoms plus two neutrons. This, and similar differences, is what powers our Sun as it converts hydrogen nuclei into more complex nuclei. Similarly, when an excited electron in an atom drops back to the more strongly bound ground state, the mass of the atom decreases by the difference in energy that is carried away by the emitted photon. Total energy is conserved. The energy stored in matter is less, when components that attract are closer together and more strongly bound. We should expect the same behaviour for gravity. When massive objects move closer together and are more strongly bound then they must lose mass.

However, the perception at the time seems to have been that different matter was able to cause the release of different amounts of some sort of energy that gave rise to a change in mass. It seems to have been thought that there had to be a change in the state of matter accompanied by emission of particles. This was probably reinforced by the perception from Special Relativity, that the speed of light, the conversion factor between mass and energy, was fixed; a universal constant. Instead, the conclusion should have been that mass can be emitted as kinetic energy and does not require the emission of particles or radiation. It also implies that the conversion factor varies.

There is no reason to require that matter needs to change state or radiate waves or particles as it moves closer to other matter. It can release stored energy (mass) as kinetic energy of motion. It gains stored energy from the work done to lift it higher against a gravitational field – a gradient in gravitational potential energy. This step in the understanding of mass, gravitational potential and gravitational attraction has taken over 100 years to be appreciated.

We haven't specified the mechanism or mechanisms which store the mass, but we can say unequivocally that it is stored in the object. Moreover, it has been observed that every known particle has an antiparticle of opposite (or zero) charge. When such matched particles and antiparticles meet they annihilate leaving no mass. All the energy can be radiated away as photons, which have energy but no mass, provided both energy and momentum are conserved. Thus, all mass is stored energy. Energy, in the form of momentum, trapped at a mean location. This conservation of momentum, as well as energy, tells us more than has been realised, and we will come back to this later.

Conversely, we can say that any and every thing that can confine energy/momentum to a location gives rise to mass. Thus, the mass of a fixed container of gas increases (by a very, very small amount) in proportion to the temperature of the gas. A hot brick has more mass than the same brick when cold. Massless particles such as photons trapped in a box lined with mirrors also give rise to increased mass.

The previous concept of mass was somewhat confused. Special Relativity, which holds when there is no gravitational force, has an "invariant mass", also known as rest mass, which is fixed if there is no motion between the object and observer. Older textbooks also had mass increasing with speed to give a supposed "relativistic mass". This has been debunked [6]. Under Special Relativity, mass is independent of the observer's frame, while kinetic energy is dependent on (invariant) mass and the relative velocity of the observer. The new perspective has mass as energy whose amount can vary with gravitational potential and whose inertia changes with speed. However, it rejects that mass varies with motion relative to the observer. It has the inertia of mass increasing with the speed of the object relative to the background field (see later). Under General Relativity, rest mass cannot be unambiguously defined in terms of an object's energy and momentum because the gravitational field also contributes to, or alters, the energy and momentum. It has objects having different mass because the lengths and time perceived by observers depends: i) on their motion, ii) on their gravitational potential relative to the location of the object being observed, and iii) on the acceleration field felt by the object. It has the geometry of spacetime curved by the surrounding energy/momentum. Time and distance are malleable and subjective. Only their combination into a universally constant speed of light at the freely-falling observer has an independent reality. All this can be rejected.

The new, simpler understanding of gravity.

The same, seemingly unchanged, matter, at the same temperature, holds or stores less mass when the density of surrounding matter increases. Gravitational potential energy is the total energy stored in a given quantity of matter. Gravitational attraction arises from matter not being able to hold as much mass when closer to the mass of other matter. The gradient in stored energy with position causes the force. A larger background field from other matter decreases the amount of stored energy (mass) and momentum that can be trapped by matter. The same body of matter (that currently stores rest energy $E_0 = mc^2$) stores less energy when the magnitude of the field from other matter increases. It gets released as kinetic energy of motion. It can be recovered, and gets stored in the object, from the work needed to move it further from other mass.

The background field

However, what is the nature of the background and mechanisms that alters the properties of particles/waves, giving sensitivity to motion and differences in mass? The first step towards an answer is the acceptance that a background field (or medium, or aether) that enables waves and particles to exist, move and obey conservation of mass and energy, is essential. It was first proposed to explain action-at-a-distance. Rubbing an amber rod could make nearby hairs stand up, a magnet could attract metal objects, and planets could be gravitationally attracted by the Sun. All these effects are at a distance, across seemingly empty space. Einstein, after developing Special Relativity, at first claimed that a luminiferous aether or background was superfluous. However, he later conceded that; "*According to the general theory of relativity space without aether is unthinkable; for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time*" [7]. An invisible medium (a field or fields) that can carry light and other radiation, and enable forces including gravity to act at a distance, is essential. However, he appears to have concluded that spacetime was the new aether or a core part of it.

Gravitational attraction arises from a loss in stored energy (mass), when objects accelerate as they fall in a gradient of the gravitational potential. They gain kinetic energy as they move faster and closer to each other and the total background field from other mass increases. If $E_0 = mc^2$ always holds, then it is the conversion factor c^2 that must change. This speed of propagation in the field that carries light and other forces should be proportional to the magnitude of the field from surrounding mass. Thus, it is proposed that an increase in the field increases the speed of light (c) but decreases the mass that can be stored. The work needed to lift an object higher against the pull of gravity into a region of lower c , is because the matter must take in energy for its wave/particles to maintain their particular wave state. If, matter stores mass $m = E_0 / c_1^2$ here and now, when $c = c_1$, then, if c_1 increases to c_2 , it will only be able to store energy $E_0' = E_0 (c_1 / c_2)^2$.

However, the observation that both energy and momentum appear conserved means that not all the change has to be in c . Energy is a stationary property, independent of motion. Momentum (p) depends on velocity. At low speeds the proportionality appears equal to mass times velocity (v) but the proportionality is actually $p = \gamma mv$ where $\gamma = 1/\sqrt{1 - v^2 / c^2}$. This factor is very close to one, except at speeds close to that of light where it tends to infinity. The resistance to acceleration – inertia – increases with velocity relative to the speed of light. Until we understand the mechanism that causes this behaviour we cannot rule out that it does not slowly vary across the universe or over time. The dependence on only c is because the units of energy and momentum times c have been equated using the values that they currently have locally.

Hence, the new perspective has to overcome the belief that the speed of light is a universal constant. This belief first arose in Special Relativity, which holds in the absence of a gravitational field (gradient in gravitational potential) and therefore applies within any region of constant mass density. Consequently, there is no obvious reason that a region with a different, but constant, mass density should have the same speed of light. A different region can only be reached via a gradient in gravitational potential which will give rise to a field of gravitational acceleration. General Relativity incorporates the assumption that mass and c are the same (invariant) for any constant background when the observer is at the same gravitational potential.

The concept of gravitational potential arose from Newton's universal law of gravitation. This law has the gravitational force (F) between a small mass (m) and a large point mass (M) being proportional to $F = G_N Mm / r^2$, with distance (r) between them. G_N is Newton's gravitational constant which appears to have the same value for an apple falling to the ground on Earth, to that keeping the planets revolving around the Sun. The gravitational acceleration (force per unit mass) could be seen to be proportional to the slope of a potential. That is, to the gradient (with distance r) of what came to be called the gravitational potential ($\Phi = -G_N M / r$). The potential decreases (becomes more negative) as objects get closer.

The revised understanding of the nature of gravitational potential provides a changed appreciation of Newton's "universal" law of gravitation. The new perspective has the work done against the force of gravity becoming a gain (ΔE) in stored energy per unit mass (i.e. $\Delta E / m$).

The amount, relative to a value of zero at complete (infinite) separation, is the integral of the attractive force by distance, i.e. $\Delta E = \int_{r=\infty}^{r=R} F dr$, where $F = G_N Mm / r^2$.

Hence, the fractional change ($\Delta E / E$) in rest energy ($E_0 = mc^2$) of the small mass m is, to a good approximation:

$$\Delta E / E_0 \cong -G_N M / Rc^2 = \Delta\Phi / c^2 \qquad (1)$$

where $\Delta\Phi$ is the change in gravitational potential (energy), per unit mass, with distance R from a point source of mass M .

Equation 1 is an energy-balance equation. It can be put into words: the fractional change in mass, or energy, is equal to the change in gravitational potential per unit of mass, divided by c^2 .

When the object accelerates, as it falls in a gravitational field, the energy lost as mass appears as kinetic energy of motion. The fractional change in energy is, or appears to be, independent of the size of the small mass and of the nature of the matter. This remarkable independence of the size of the mass within our solar system implies that the contribution of a mass M (of the size of the Sun) to the background field is negligible relative to that from all other mass. This is possible for a potential that falls off as $1/R$, in which contributions from opposite directions do not cancel (i.e. a scalar potential). The potential, just like air pressure, does not have any dependence on direction. All contributions add to the total, whereas vector quantities, like matched electric charges, from opposite directions cancel. If the $1/R$ dependence holds unchanged over galactic distances, it means that our galaxy and the enormous number of distant galaxies will be the major contributors. The mass of the Earth will be negligible, and even that of our single nearby star, the Sun, will be small in comparison to that from our galaxy.

Gravitational potential energy reflects the fractional release of the total energy stored by matter (or antimatter) when the field from like matter increases. The very small fractional change in mass implies that the total stored energy per unit mass is enormous, with a 1 kg object containing the energy of a 20 megaton (of TNT) hydrogen bomb. This follows from the smallness of $G_N M / Rc^2$, seen in Equation 1, unless M is enormous and confined to a small volume. The fractional loss in mass in falling all the way to the Earth's surface from nearby (say 10^5 km) space, is tiny, only 6 x 10^{-10}.

The complete annihilation of particle/antiparticle pairs into energy means that the mass of all known matter is only stored energy. This also suggests that changes in c affect all forces (including strong, weak and electromagnetic), that trap energy at a location, in the same proportion. The observed identical energy levels of hydrogen and anti-hydrogen and their rate of fall in a gravitational field implies that the effect of any changes in c on stored energy must also be identical. Thus, the fission and fusion reactions of even the most distant stars appears consistent with local behaviour. The fractional energy input (from increasing the gravitational potential) always equals the fractional energy output (as the lost mass is converted to kinetic energy when it falls).

The independence from the nature of the matter implies that the resistance of mass to acceleration (inertial mass) has a fixed proportionality (equivalence) to gravitational mass independent of the gradient in gravitational potential. This equivalence of inertial and gravitational forces, independent of the material and of the direction of the gravitational field relative to any acceleration, has been tested to high accuracy using torsion balances at the surface of our rotating Earth (Eötvös experiments). However, the matched masses are compared at the same location, time and potential. Thus, it is still possible that the value of the fixed relation between inertial and gravitational mass may vary gradually with location and time. The inertia of the same gravitational mass could still depend on an additional property of the background field. This would show up, for example, as a difference in speed, for the expected value of G_N, of stars rotating around a galaxy at a significantly different fractional distance, adjusted for mass, from the centre of a galaxy than our star is from our galaxy.

Can the speed of light vary?

The very small fractional changes in the speed of light with distance from the Earth explains why changes in c have not been noticed. However, the revised perspective reveals that they have already been observed. Every object or particle, whether matter or radiation, has a Compton frequency of oscillation (first seen as a de Broglie wavelength) proportional to the energy/momentum carried ($f = E/h = mc^2/h$ for matter, and $f = E/h = pc/h$ for radiation). The frequency of oscillation is proportional to the energy carried divided by Planck's constant h (whose units are those of angular momentum). Time, frequency, and the rate of ticking of an atomic clock are directly proportional to the energy carried as trapped momentum. The fractional changes in mass and time change in unison with the change in gravitational potential (energy). Thus, the observed gravitationally induced changes in time (e.g. faster ticking of the clocks of the GPS satellites far from the Earth) come from the increase in their stored energy, which reflects the change in c. The gravitational time dilation of General Relativity is a direct and necessary consequence of the changes in energy level of atoms, including those of our atomic clocks, with changes in potential. However, there is no reason to add in General Relativity's flexible scale of distance, except to force a constant c.

Under the new perspective the speed of light is, and must be, constant within a region of constant gravitational potential. Special Relativity only claims to apply in the absence of gravitational forces; meaning there is no gradient in gravitational potential, so it must be constant. However, the observation that atomic frequencies and clock-rates reflect mass/energy requires c, and possibly inertia, to change with mass density. The determination of the degree that it varies across regions of different gravitational potential requires highly accurate measurements of position and time across regions with large differences in potential. This is not straightforward in our solar system when the variation in potential causes a bending of electromagnetic signals. As will be discussed under the section on how the predictions of General Relativity can be reproduced, the new perspective's increased speed of light has the same effect as General Relativity's supposed (but disputed) contraction of distance.

The observations that the speed of light is independent of the speed of the source does not establish that the speed of light always has the same value over time or when there are large changes in potential. The fractional changes in potential encountered along the paths of light from distant binary star systems, for example, will be negligible compared with the accuracy with which their orbits can normally be known. Observation of changes over time require the background from all other matter to be compared over timescales in which the universe evolves.

Initial consequences of the changed perspective on gravity

Consequence 1: The field that gives rise to gravitational attraction alters the speed of light. An aspect of this background field must also determine inertia.

Consequence 2: The $1/R$ dependence of potential implies that distant galaxies will dominate. This explains the smallness and apparent constancy of Newton's gravitational "constant" and the force of gravity. The explanation of the apparent independence of the strength of gravity on the amount of mass independent of type of matter is because all mass is just stored energy. The explanation of the direct proportionality on the magnitude of the large mass and only on the gradient in potential is the smallness of observed changes relative to the total potential. This necessarily implies that the effect of a given change in stored energy will double if the total background potential is halved.

Consequence 3: The faster clock-rate at higher gravitational potential reflects the increase in stored energy. The change in time reflects the change in stored energy (mass) of atoms. No change in distance scale (the "space" between objects) is required.

General Relativity, makes the subtly different interpretation that the faster time of clocks is an alteration of "the standards of time" when objects are at a higher gravitational potential than that of the observer [8]. If time was going faster, then it was assumed that a photon of constant frequency would appear to oscillate more slowly (be redshifted). The new perspective is that time (ticking of clocks) is faster because more energy is carried by matter at a higher potential. The mass of atoms is greater at a higher gravitational potential and the atoms emit, and absorb, photons of higher energy. However, most textbooks on General Relativity have the wavelength of photons being stretched (redshifted) when moving to a higher gravitational potential. This has led to the belief that "photons lose energy in escaping a gravitational field". They have no mass but they carry energy and it is/was assumed that they are attracted in proportion to the energy that can be delivered by their momentum.

The new theory has the frequency and energy levels of all atoms increasing with increasing distance from a concentration of mass. This is required because mass as stored energy demands that the energy levels of atoms are blueshifted by the work done in raising them against the force of gravity. Hence, the emitted energies of the photons from all transitions of atoms at a lower potential are smaller. However, the energy of a photon is unchanged after emission because it is massless, in agreement with Newton's law of gravitation. It is also in agreement with the observation that the speed of light is independent of the speed of the emitting and receiving objects; but their relative motion is still reflected in their Doppler shifts. Under the new perspective the speed of light is dependent on the magnitude of the background, but insensitive to movement relative to that background.

The famous Pound-Rebka experiments [9] taken to confirm that photons were redshifted have a different explanation. The experiments showed that photons needed to be given a boost in energy to be resonantly absorbed by a matched detector at a higher altitude. The needed boost is not because photons are redshifted and atoms are unchanged but that photon energy is unchanged, while atoms at a higher potential are blueshifted. Einstein, as early as 1907, consistently stated that the frequency of atoms at the surface of the Sun (lower gravitational potential) would be slower than those at the Earth [10], based on the Equivalence Principle. This blueshift of atoms has also been claimed under

General Relativity [11,12]. In his 1916 derivation, which was the first based on the equations of a distorted metric, Einstein stated: “Thus the clock goes more slowly if set up in the neighbourhood of ponderable masses. From this it follows that the spectral lines of light reaching us from the surface of large stars must appear displaced towards the red end of the spectrum” [13]. The new perspective agrees with this statement which amounts to a redshift of atoms deeper in a gravitational potential. Strangely, most astrophysicists appear (wrongly) to believe that the photon loses energy in escaping a gravitational field. However, the blueshift of atoms (higher in a gravitational potential) is consistent with photons having no mass. The momentum carried and delivered by the photon is unchanged (conserved) if there is no relative motion between source and receiver. The size of the difference between atoms and photons is the same but the understanding of how the effect arises is different.

Consequence 4: A local gravitational redshift reflects the reduction in trapped momentum (stored energy) when the field from other mass is larger and the speed of light is faster. It is distinct from the Doppler shift due to relative motion and does not imply or require an expansion of space.

The nature of matter and the background field

A first clue about the nature of the background field is the that the $1/R^2$ dependence of gravitational force arises from the gradient of a potential energy that only varies as $1/R$, with distance R from massive objects. This should be seen as an enormous surprise. How can the effect or influence of potential energy only fall off as $1/R$ when the surface area around a source of stored energy (mass) increases as $4\pi R^2$? The influence of light, the force from the flux of energy-carrying photons hitting the same sized surface, decreases as $1/R^2$, because the total flow of energy is conserved. The $1/R$ behaviour of gravity is equivalent to the number of “gravitons”, the supposed quantised provider of the attractive flux or flow of gravity, increasing (by R) with distance from their source!

However, we can be quite confident that the $1/R$ potential is the important property of the field. If the gravitational acceleration (force per unit mass) was the underlying determining property then nearby sources should always dominate. We feel the force of Earth’s gravity more strongly than that of the Sun, but the planets rotate around the Sun. Mach’s principle, as seen in the constant orientation of gyroscopes and pendula relative to the “fixed” stars, means that distant sources actually dominate. It is also required by the small fractional changes of Equation 1 and the seemingly tiny strength of gravity per unit of mass. The force depends on the gradient so we do not feel the strength of the potential, only its fractional rate of change with distance from a source, i.e. the amount relative to the total potential. In addition, it has been experimentally established via something called the Aharonov-Bohm effect, that the potentials of both electromagnetism and gravity, rather than the forces, are the underlying quantities that determine behaviour [14,15].

The loss of mass with a changing speed of light explains gravity, but does not immediately explain why the effect of the gravitational field falls off only as the inverse of distance. It also does not explain why the speed and direction of any motion, including rotation, of massive objects remains constant when no forces are acting. Yet, acceleration, changes in linear velocity and rotational direction, are resisted. This resistance to change, inertia, is proportional to mass but sensitive to changes in direction even at constant speed, when the amount of energy is unchanged. Inertia and the vector nature and conservation of momentum require an additional dependence on the background beyond a simple scalar effect on the energy that can be stored. The resistance to changes in direction and speed necessarily implies both a finite amount of rotation and a finite spatial extent of particles of matter.

A second clue as to the nature of the background comes from elementary particle physics. The mechanism for how elementary particles gain mass in the Standard Model of particle physics is called the Higgs mechanism. The masses of all particles is proposed to arise from, and be proportional to the strength of their interaction with this Higgs field. The mechanism is based on the observation that the exchange particles (gluons) of the strong force and of the electromagnetic force (photons) are massless, whereas those of the weak interaction have large masses. Mass appears to arise from a breaking of mirror symmetry, and only the weak interaction violates parity where mirror interactions are not identical. Weak interactions show a dependence on chirality (a left or right handedness), and matter and antimatter have opposite handedness. The mechanism is seen as involving a spontaneous breaking of an underlying global symmetry (broken gauge invariance) that includes a background-dependent scalar interaction. This implies that the strength of gravity (and hence mass) must depend on the total surrounding scalar field (from mass), even if it is uniform and isotropic. Contributions from opposite directions do not cancel.

It is said to be "a spontaneous breaking" in the sense that the symmetry was initially present but was broken by a random fluctuation, as in a ball rolling off in one direction from the top of a perfectly hemispherical hill. If this is the source of mass then we must be living in a world where there is an interaction between elementary particles and their surroundings, that gives rise to their mass, which is scalar and no longer gauge invariant. The initial gauge invariance has been broken. Thus, the discovery of the Higgs boson and the remarkably successful predictions of the Standard Model implies that mass, and hence gravitational attraction, has arisen from a background dependence that is scalar (non-directional) and related to handedness. The gauge invariance of the source of gravity was initially present but has been broken. This is consistent with a scalar potential providing a force that depends on the fractional change in the total background field; and with mass per unit matter and inertia increasing over time as matter clumps under gravity. It is inconsistent with a Newtonian gravity with a fixed constant of proportionality independent of the total background and with General Relativity which is locally gauge invariant.

The broken gauge invariance therefore suggests that the $1/R$ dependence arises from a handedness of the background that inhibits or opposes the decrease in flux (influence) with distance. A two-component chiral background that acts something like opposing torsional springs where winding up of one is resisted by an unwinding of the other, seems to provide a first step towards a plausible picture. Such a picture would have the impact of a small change in just one component being halved by being shared equally by the other component. For such springs, the mean tension will hardly change if the two components have similar strength, i.e. the difference between the components, their asymmetry, is small. However, there will also be residual effects due to any asymmetry. It is proposed that inertia, the resistance to changes in motion, is related to this asymmetry. It is observed that the speed of motion increases the inertia of mass (by γ) but slows the decay-rate of unstable elementary particles (by $1/\gamma$). Therefore, it is proposed that the energy is stored between opposing chiral components of particles. For small asymmetry the mass is determined by the mean speed of propagation in the field, but the small difference in speed with direction of rotation relative to direction of motion (chirality) slows the mean oscillation speed (frequency of oscillation). The new balance then remains for the new constant speed. There may be a better picture of the underlying mechanisms but this can be seen as a start to understanding both the $1/R$ dependence and inertia.

A $1/R$ dependence also requires that the influencing flux does not transport energy, otherwise the total energy must increase with distance from a source of gravity. This is also consistent with the strength of gravity of a given mass being conserved over time. Therefore, it is proposed that, instead of carrying energy, the background field (flux) determines how much energy massive objects can store. It does this by altering the speed of light. This challenges the assumption, based on General Relativity, that gravitational "waves" are travelling distortions of spacetime that carry energy. However, the LIGO detectors of gravitational “waves” will also detect travelling variations (wave-like, if from periodic oscillations) in the speed of light. Hence, the claimed loss of energy of binary pulsars via gravitational radiation must be questioned.

An examination of the calculation of the apparent energy loss of binary pulsars shows that the reference energy (no radiation) is based on a non-relativistic circular orbital equation. This reference value and orbit does not change with time. It does not take into account known and necessary effects of the finite speed of light such as retarded apparent positions and Doppler shifting. It also omits the perihelion advances of eccentric orbits that can be attributed to changes in momentum from changes in mass, but which General Relativity attributes to changes in time. Thus, the revised perspective claims that it is omissions in the calculation of orbital energy and its’ rate of change that leads to the apparent loss of energy. Cyclic oscillations in potential, with position and speed relative to an observer, do not transport energy to a new location. The claim that gravitational “waves”, in terms of travelling fluctuations in spacetime, can transport energy has also previously been called into question [16].

Towards a deeper understanding

The new perspective links gravity to particle physics and quantum mechanics via the shared background. This is strongly supported by the speed of propagation of electromagnetic fields being the same as that of gravity. It is proposed that mass arises from any force (strong, electromagnetic, weak or gravitational) that confines energy/momentum to a location. It is not just the purported “Higgs field”, but any trapping of momentum, that gives rise to mass. The explanation of the nature of particles and their fields is linked to the explanation of the gravitational field.

The change of mass with changing background explains gravitational attraction, but it does not explain why objects resist changes in speed or direction (have inertia) yet happily continue at a new constant speed after acceleration. It also does not explain why inertia increases, but not mass, when an object moves faster relative to the background. If mass increased with speed of motion, then the decay rates of unstable elementary particles would be expected to increase, but rates are observed to decrease. These observations indicate that particles must have a “memory” (altered property) of their current movement relative to a centroid of motion and that massive particles are sensitive to changes in their speed of movement relative to the “memory” of surrounding matter (i.e. the background).

All particles have a Compton frequency of oscillation, which is consistent with quantum mechanics and with particles being cyclic wave states. The revised gravitational perspective suggests that elementary particles are cyclic ‘standing-wave’ states in three spatial dimensions that trap momentum. They are repeating patterns of superimposing wave components in which the location of the nodes cycle. This seems possible if, for example, there are pairs of components that are π out-of-phase or triplets that are $2\pi/3$ out-of-phase that trap a force of constant magnitude about a mean location and direction, but with oscillating components that are continuously varying. The volume of such a state would be determined by the speed at which components from other directions can change the direction of the force. This would seem to be able to provide a mechanism in which a more rapid rotation of opposing components can compensate for a slower speed along components. The increase in frequency and stored energy, and the reduction in dimensions, reflect the increase in force and rate of change of momentum needed to maintain the same oscillation pattern. Work must be done to maintain the equivalent cyclic wave pattern if the speed of light/propagation decreases. This appears consistent with an increased speed of light reducing the stored energy of all particles.

Waves in one and two dimensions spread out, that is, diffuse. However, oscillating elementary particle states, have confined but finite locations in three dimensions. They are what should be seen as “wave-particles”. Their wave-functions do not diffuse or dissipate. This implies that the pattern of superimposed (interfering) wave components of their four-vector momenta are oscillating but the total momentum is continuously conserved. Therefore, it is proposed that the propagation speed of each component is the propagation speed of the medium. However, there can be components from multiple directions and of different magnitudes contributing. All wave-particles are repetitive patterns of multiple component about a mean location. Massive wave-particles trap opposing momenta, while massless exchange “quanta” (photons, gluons, neutrinos) have supportive components. The latter patterns can only exist by travelling at the maximum speed of the medium. This speed is determined by the mean magnitude of the two-component chiral background. It is further proposed that the cyclic frequency, per unit energy, of all wave-particles, including massless quanta, varies with the asymmetry between matter and antimatter contributions to the background.

It appears probable that movement of like chirality, but oppositely directed, components relative to a balanced background will increase the rotation rate of one component and reduce the other to maintain the force balance. The relative speed of rotation of the pair of components, around the axis of the direction of motion, changes. The increasing difference in the resistance to rotation of the chiral pair, with speed along the direction of motion, produces a slowing of the mean frequency of oscillation and (possibly) a reduced amplitude in order to keep the total internal angular momentum constant. The frequency of oscillation is reduced but the stored energy is unchanged. The result is that massive particles have a “memory” of their speed relative to the background and relative to their current pattern. Such particles will also come in pairs of opposite chirality (i.e. matter and antimatter). Both particles will trap the same angular momentum because the oppositely directed components, although of the same chirality, counter-rotate. Hence, they will both have the same positive mass (i.e. stored energy) at or in the same background. This gives rise to an inertia that is dependent on both mass and chiral asymmetry of the background and is sensitive to changes in velocity.

Massless photons are sensitive to the magnitude of the balanced background of opposing chiral components. It determines their speed, but that speed is independent of the speed of the emitting source. However, the photon still retains the information (internally) because observed Doppler shifting depends on relative motion between source and receiver. The explanation must lie in the self-propagating nature of electromagnetic waves. They are oscillations between electric and magnetic fields which both travel at the speed of light. Their propagation speed is independent of the energy carried but must have a finite extent and rotation perpendicular to the direction of motion. The rotation frequency is faster and its’ extent smaller with increasing energy carried. Their emission and later absorption conserves linear and angular momentum.

A clue to the nature of the wave pattern is that a photon, except that it is moving at c , has properties that match that of a stationary co-rotating positron and electron, both of spin ½, of the same total energy. The components of their wave patterns should therefore be the same but differ in their phases (and possibly their relative location).

Other particles, notably the three types of neutrinos which are massless according to the Standard Model, must also have components such that their combined state can only maintain its existence by travelling at c , and does not trap angular momentum in a way that is resisted by asymmetry of the background (has zero inertia). However, the existence of three types of neutrinos implies that there are three ways of achieving this by different numbers of components with different geometric and phase relations. They should then have different oscillation frequencies when carrying the same momentum. Oscillation between neutrino types does then not require that they have mass, as has been routinely claimed.

It must be stressed that these proposals are speculative. However, they may suggest a path towards a Standard Model that incorporates all four fundamental forces and that can predict all wave-particle masses and interaction strengths from first principles. The revised understanding also throws a light on quantum mechanics. It indicates a solution to the problem of Schrödinger's cat and avoids the need for so-called "entanglement". An oscillating wave-function can have a fixed angular momentum vector relative to one axis, but an oscillating value relative to an orthogonal axis. Wave-particle states can have definite properties but be continuously oscillating. Testing of its spin along one axis can always give the same result (up or down), but a test along an orthogonal axis can give an up or down result with equal probability, and reset it in the new direction. The wave-particle can appear to be in a definite state (when viewed from the same direction). It is not a mixture of all possible states, but the state is not known before measurement and is reset by measurement. The number and magnitudes of the wave-particle's components is fixed but their relative phases determine its orientation in space. The wave-function does not "collapse" on measurement. Properties exist independent of whether they are observed. The cat is not in an equal mixture of being alive and dead. The probability reflects the randomness of the phases of the detecting interaction relative to the phase of the wave-particle. Pairs of wave-particles with oppositely directed angular momenta (or polarisation) will maintain those directions after separation. There is no need for faster-than-light communication.

Introduction to Full Relativity

The new theory has been christened Full Relativity because observed behaviour is dependent on all matter, via its energy/momentum. The properties of wave-particle states that give rise to the background field also depend on the properties of that field. However, the field changes objects, not the spacetime in which objects dwell. It replaces the supposed fabric of spacetime in both Special and General Relativity. A fuller presentation of the existing consensus model, based on Geneal Relativity, with its problems, assumptions, and why it needs to be replaced, is given in Appendix A.

The invisible field that permeates all space, that carries light and gravity, and enables interactions at a distance, determines the properties of objects and the speed of light. However, the scale of distance (i.e. space) is not flexible. This contrasts with General Relativity which varies the scale of space and time, in which objects of ill-defined mass are embedded and the speed of light is fixed (for the local stationary observer at a constant potential). General Relativity has the scale of space dependent on relative location and movement of both the observer and surrounding energy/momentum.

Full Relativity challenges many of the strongly held beliefs of current theory. It claims that both the speed of light and the mass stored in the same matter vary with the magnitude of the field. It also claims that the momentum and inertia of objects depend on an additional aspect of the background. Finally, it claims that "space" is simply the distance between objects not in relative motion. This distance cannot, and does not, change with any motion of the observer or with the density and movement of surrounding matter. There is an underlying reality that is independent of the location and motion of the observer. Any effects on distance are only apparent and not real.

The dependence of unstable particle decay rates on linear motion is because oscillation frequency slows and inertia increases with velocity relative to the nearly stationary background. It does not have Special Relativity's dependence on relative motion of the observer or General Relativity's dependence of time on a generalised form of gravitational potential. It does not add a distortion of distance to keep light-speed constant, when it is not. It rejects the assumptions of the "principle of relativity" and of the strong "equivalence principle". There is no solid evidence that they hold or that spacetime exists.

The new theory proposes that the nature of momentum, the $1/R$ dependence of gravitational potential, the handedness (chirality) of weak interactions and the Higgs mechanism for giving particles mass, indicate that a two-component, chiral background from matter and anti-matter is required. The two-component background appears to act like nearly equal opposing springs, where winding up of one is (approximately) halved by an unwinding of the other. It means that gravitational potential, the effect on energy of an excess of either component, only falls off inversely with distance rather than with distance squared. Consequently, the enormous number of distant galaxies dominate in determining the total field and the speed of light. The fractional changes are small, so that gravity appears weak.

It is proposed that the field arises primarily from competing, but nearly equal, contributions from both matter and antimatter galaxies. These galaxies will have contracted as matter clumps, increasing inertia. Thus, they could be expected to have contracted into interlaced, but gravitationally bound, separate regions. The presence of antimatter galaxies will then not be revealed by their collision with matter galaxies. The chiral components of the background will be nearly matched except within isolated concentrations of one type of matter, such as galaxy clusters and the core of galaxies.

Where the mistakes began

The first point of departure from Einstein's theory, and the explanation of why spacetime is an illusion, occurs at the postulates of Special Relativity. The first postulate: the "principle of relativity" claims that the laws of physics are completely independent of any constant motion of the observer moving with the objects being examined. It applies in the absence of "gravity" (i.e. of a gradient in potential). An observer in an enclosed space, for example in a windowless train carriage smoothly travelling at constant speed, appears to be unable to tell whether they are moving. Two people can still play table-tennis and a ball that goes straight up comes straight down. However, the postulate requires physical laws for any object moving at constant velocity to be the same as they are for the object at rest. Thus, it claims that an observer in an inertial (non-accelerating) frame cannot determine an absolute speed or direction of travel in space, and may only speak of relative, not absolute, speed or direction. This is a strange and remarkable leap of faith. Full Relativity agrees that it is still possible to play table-tennis but claims that the faster the train is travelling, relative to the background field, the slower time proceeds and the greater is inertia. Hence, the players' watches will tick more slowly and they will have to hit the ball harder. Movement relative to the background, from all other mass, slows time (clock-rate) and increases inertia, but does not change distance. The observed independence of speed, relative to the background, applies only to massless objects (e.g. photons).

Full Relativity claims that for massive objects, the apparent lack of change in behaviour is only in the limit that the speed of movement relative to the background from the rest of the mass in the universe, is small relative to the speed of light. The observations of the effects of high-speed motion are due to a real slowing of time with movement of massive clocks relative to an effectively stationary background from other mass. The slowed decay rates of unstable elementary particles are because they are moving at high-speed relative to the locally balanced background. If observers travelling at high-speed in a linear accelerator could make observations, they would see stationary, unstable elementary particles and clocks, decaying and ticking faster relative to their clocks.

Einstein's original second postulate was: "*that light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body*"[17]. In his analysis he then claimed: "*that light (as required by the principle of the constancy of the velocity of light, in combination with the principle of relativity) is also propagated with velocity c when measured in the moving system*". This is a misunderstanding. It is not the measured speed of light that is required to be independent of movement of the observer. The observational requirement is, and was, that the underlying speed of light is independent of the speed of the emitting object.

For a constant underlying speed of light, the distance travelled by light, per unit of observed time (ticks of a clock), increases if the observer's clocks are slowed. Keeping the measured speed of light constant for observers whose clocks are slowed requires distances (the space between objects) to be reduced. Under Full Relativity, time dilation arises because the clocks of objects and observers (which both have mass) are slowed by high-speed motion relative to the background from all other massive objects (primarily galaxies). However, the speed of (massless) light is not affected by motion relative to the background. Consequently, its speed will measure faster, but is actually unchanged if the background is constant. The misunderstanding, that the measured speed must be constant, explains why the "space" of Special Relativity's spacetime, the apparent distance between observed objects, is reduced by the slowing of time when there is movement of the observer relative to the background. The same distances travelled take smaller amounts of time (a smaller number of ticks) of slower clocks. The dilation of time is real for observers and clocks moving at speed relative to the background and the contraction of distance is only apparent. The spacetime, of Special Relativity, has it that movement relative to the observer slows clocks. It then needs a real contraction of distance to maintain a constant measured speed of light, whereas the underlying speed remains constant within a region of constant gravitational potential.

Why spacetime must be replaced

The fabric of spacetime was designed to give a constant measured speed of light. It could appear to give correct results for Special Relativity, which applies when there is no "gravity". Special Relativity holds when there is no field of gravitational acceleration, i.e. within a region of constant gravitational potential. The magnitude of the background potential and speed of light are therefore constant. However, the evidence is not that the measured speed is independent of high-speed motion of the observer. Instead, the evidence is that the underlying speed of light is independent of the speed of the emitting or receiving object. This is consistent with the light emitted from binary stars. If the light emitted by a star moving away travelled more slowly ($c-v$), then by the time it reached us it could be overtaken by light emitted later in its orbit when it was moving towards us (at $c+v$). There is no evidence for such an effect.

A constant underlying speed is consistent with the inability of any experiments, like the interferometer experiments of Michelson and Morley, to see shifts in the arrival time of light because of motion relative to the background. It is also consistent with the aberration of starlight. This is a movement in the apparent direction of a star with the speed of the Earth's movement in its orbit at right angles to the direction of the star. The effect is similar to what we observe when travelling in the rain. Rain that is coming from one side when we are stationary appears to come increasingly from the front as our speed increases. The arrival time depends on distance travelled at constant speed, and the change in relative distance of the source and receiver causes advances or delays in the signal arrival time. However, there is still a Doppler shift in received wavelength whose amount depends on the relative velocity between source and receiver.

Dilation/contraction of spacetime is based on a misinterpretation of how a slowing of clock-rate, with speed of the movement of the clock relative to the background, affects the apparent speed of light when its underlying speed is constant. In Special Relativity, time being slowed was wrongly assumed to mean that more time would elapse while light at a constant speed appeared to travel a given distance. Light would then take the same time to travel a contracted (less) distance. This kept the measured speed of light, rather than the underlying speed, constant. Agreement with the transformation that Lorentz proposed to explain observations (see Appendix A) can be achieved for a constant underlying speed of light. However, the interpretation of this transformation has to include a correction for movement of the object during transmission of light signals. This leads to a simplified transformation that does not require a distortion of space.

There are basic flaws in the argument used by Einstein to conclude that only relative motion mattered. He assumed (in his thought experiment) that the lack of time-dependence of position coordinates after a two-fold application of the Lorentz transformation (v followed by $-v$) meant that there had been a return to the stationary frame. This faulty deduction led to the conclusion that each moving observer would see the other's clock slowed. However, the frames being compared only overlapped at time zero. The "two-fold" transformation was comparing frames moving in opposite directions away from the origin of the stationary frame, after initial coincidence. The apparent return to the stationary frame arose from using the x coordinate to mean the separation of all matched points in two frames (after overlapping at $t = t' = 0$). The direction of the distance from the origin of the stationary frame was ignored. The slowing of time is observed for massive clocks (including unstable elementary particles) moving relative to our nearly stationary position in the background from all other massive objects. If the observer is moving at high-speed relative to a clock that is stationary in this background, then the stationary clock should be found to tick faster, not slower, than the observer's clock. However, this expectation has not been tested.

General Relativity's spacetime distorted by massive objects, with its non-Euclidean geometry (altered by the potential) is also an illusion. The original ("flat") fabric claimed a constant measured speed of light by interpreting $t' = t / \gamma$ as slowed (dilated) time but $x' = \gamma x$ as shorter rods (less distance) [17]. The reality is that, for constant backgrounds c is constant, time is slowed by movement giving an apparent increase in distance travelled. When the background potential varies, giving rise to acceleration, a fabric with distortions of distance matching the distortions of time still does not exist. Instead, time (clock-rate) is slowed when an increased background increases the speed of light and reduces mass. Full Relativity has slower (dilated) time paired with faster light-speed but constant distance, whereas spacetime has slower time paired with shorter distance giving constant c .

General Relativity used the concept of spacetime to try and explain behaviour when there was acceleration. Through additional generous assumptions, as set out in Appendix A, it was concluded that the geometry of a fabric of spacetime could be altered by the density of surrounding energy and momentum. The assumptions included a spacetime with a constant mass and measured c , for a freely-falling observer, who is travelling with the object, and therefore at the same gravitational potential. When there are differences in potential between object and observer, General Relativity allows the light-speed and mass (m) to appear to vary for an observer at a different gravitational potential. Thus, an underlying reality is lost (Appendix B), behaviour has become dependent on the location and movement of the observer. Full Relativity has real variations in c and m . For both theories the values depend on the surrounding field (the background) that arises from energy/momentum. However, Full Relativity does not allow distance (space) to be distorted; although distances can appear contracted, when the light-speed is faster and clock-rate slower, at lower gravitational potential, or light-speed appears faster and clock-rate is slower because of movement.

There is no evidence that the scale of space can, or should, expand or contract, or the speed of light be an invariant at all locations of the observer. The proposal that a freely-falling (and therefore accelerating) observer, who must necessarily be moving into a region of different gravitational potential, in which clock-rate is known to differ, should not see any change in physical laws, must be rejected. The Hubble redshift of distant galaxies cannot be attributed to a Doppler shift due to increasing velocity with distance, nor can it be attributed to an ongoing expansion of empty space that stretches the wavelength of light, but not the scale of massive wave-particles.

Consequence 5: The geometry of space is always Euclidean, there is no evidence that the scale of distance between objects, not in relative motion, is flexible or dependent on matter or energy density.

Relativity's predictions are reproduced

Full Relativity automatically reproduces many of the standard predictions of General Relativity when the background is similar to that currently observed locally. This is because General Relativity's fractional change in time ($\Delta\Phi / c^2$) [18], with difference in gravitational potential, has the same magnitude as Full Relativity's fractional changes in mass and time, and its change in distance matches Full Relativity's change in apparent distance from a changed speed of light.

Einstein's first prediction from General Relativity explained the already observed advance in the perihelion of Mercury. General Relativity has time slowing as potential reduces, which is taken to mean that less time elapses while events occur. Full Relativity has the speed of Mercury in its eccentric orbit increasing, as its mass reduces closer to the Sun, but its momentum is conserved. Hence, it travels faster and takes less time for a given distance when closer to the Sun. Full Relativity has no change in distance scale, while General Relativity claims a matched contraction in distance. This supposed contraction in distance matches Full Relativity's apparent contraction because the speed of light is faster. However, the effect of a mean change in distance on the advance of the perihelion (per orbit) is negligible for a nearly circular orbit, and is ignored in the General Relativity' prediction. Thus, the predictions agree because only the distortion of time is used and no distortion of space.

Einstein's second prediction from General Relativity was that light would be bent by a massive object such as the Sun. The amount of bending was claimed to be double that from just the loss of energy from the assumed gravitational attraction of all particles. Einstein's calculation in support of this doubling, published in English, after the observations of the changed apparent location of stars during the solar eclipse of 1919, appears to be faulty (see Appendix A). The calculation has had an unexplained factor of two added. Subsequent calculations have all been based on General Relativity's matched additive distortions of both time and distance incorporated in Einstein's equation (but not used in his original published calculation). Half the bending of light comes from its supposed loss of energy (redshift) in a gravitational field, and an additional half from the matched contraction of space. This contraction was introduced to ensure that the local speed of light remained constant. Under Full Relativity it cannot be gravity (in terms of an attraction due to the photon's momentum or a distortion of space) that doubles the bending of light because light does not gain or lose energy in a gravitational field, and distance is not distorted by matter. However, a gradient of light-speed (in vacuo) will also cause light to bend, by twice the amount because it oscillates between an electric and magnetic field, but it will bend towards the increase in speed. This is opposite to what is observed for light slowed by electromagnetic interactions of photons with electrons within a stationary medium (see Appendix B).

Einstein's third prediction was a gravitational redshift of photons escaping a gravitational field. As stated already, the effect was first observed in the need for photons emitted from a lower detector to be given a Doppler boost in energy (by upward motion of the source) if they were to be resonantly absorbed by a matched detector higher in the field [12]. Under General Relativity, the effect is due to clocks running faster in a region of higher gravitational potential so that photons needed to be given a boost in frequency (energy) to match a supposedly unchanged detector. The loss in energy of photons, although they are massless, has generally been attributed to them being gravitationally attracted in proportion to their momentum. This had the side-effect of necessitating that all forms of energy/momentum give rise to gravitational attraction. Full Relativity, in conjunction with particle physics, has the much simpler explanation that (quantum) oscillation frequency depends on the energy carried. The atoms of the same massive clock and the matched detector, at a higher gravitational potential, have more stored energy and hence a higher frequency. Photons, with no mass have an unchanged energy after emission. The apparent redshift of photons is, instead, a blueshift (increase in energy) of the atoms of the detector. It is the objects that change, not the empty spacetime between them. General Relativity's explanation in terms of a change in time with location is unacceptable because such a change should apply to both the atoms of the detector and the photons. The explanation, as a loss of energy of a massless photon, is also inconsistent with Newton's law of gravitation, because it's force of attraction is proportional to mass.

A fourth prediction, by Shapiro, is a delay in the travel time of electromagnetic radiation (e.g. radio waves) from planets or spacecraft as they pass near or behind the Sun. A delay of the expected amount has been observed. However, the calculated delay is determined by a fit to the expected change in signal arrival times due only to the amount bending changes the path length. This removes changes in apparent orbit from any changes in light-speed or distance and so the predictions will match. Any increase in the speed of light should lead to an apparent contraction of distance. It is not clear whether this is removed by the method for determining the delay. It should reduce the delay. However, since General Relativity assumes a slowing of time is matched by a contraction of distance (or that a slowing of time gives an increase in perceived speed of light) the predictions can agree.

Other predictions, such as frame dragging, appear to relate to the wave nature of particles and interactions, and to the finite propagation speed of light. These imply that the strength of interactions will be altered by relative speed of motion, as seen in the Doppler shifting of photons. Thus, the component of the mass of a rotating spherical object, moving towards a small nearby object will have a larger effect than the component moving away. This will lead to torques on objects of finite dimensions or with angular momentum vectors (gyroscopes) pointing in different directions to the axis of rotation of a massive sphere (e.g. the Earth). This amounts to frame dragging.

It appears that all the confirmed predictions of Special and General Relativity can be reproduced by Full Relativity. Firstly, as with a blueshift replacing a redshift, it can be the understanding of the cause that changes. Secondly, General Relativity's claimed changes in distance('space') do not, in many cases, come into the predictions that have been tested. Thirdly, a degree of flexibility has been allowed in the interpretations of the mathematics and the meaning of coordinate symbols, and the distinction between real and apparent effects. For example, changes in the magnitudes of time and distance ('space') versus changes in the intervals of time and distance (see Appendix B). This is highlighted in the predictions for the bending of light and whether light's real, measured, or apparent, speed changes. General Relativity has slower time meaning that at a lower potential less time elapses while events occur and this is matched by a contraction of distance to double the amount of bending. This would seem to keep the speed of light constant along the path of the photon, and so should prevent bending. These questionable inconsistencies ultimately come back to the nature of reality as discussed in Appendix B. Full Relativity has slower time arising from a reduction in the energy of clocks meaning they tick more slowly, with the intervals between ticks being larger. However, the bending and its doubling arises from increases in speed of both electric and magnetic fields.

Full Relativity claims to also remove the "problems" and the unexpected additions to General Relativity required by cosmological observations, and these will be discussed next.

Escaping the Dark Side of the Universe

Many scientists, outside astrophysics, have been anxious over the widespread acceptance that invisible "dark matter" and "dark energy" make up 95% of the universe. These were not predicted and were introduced ad hoc to explain unexpected results. The first surprising observation was that clusters of galaxies, and the outer stars within galaxies, were moving so fast that they could not be held together by the gravity from the observed amount of visible matter. This led to the hypothesis that galaxies were immersed in a diffuse halo of invisible matter – "dark matter". This new type of matter did not emit or absorb light or interact significantly with ordinary matter, except via its gravitational attraction. Subsequently, it was also observed that galaxies and galaxy clusters also bent light more than expected. The observed amounts of bending and lensing needed about five times as much dark matter as ordinary matter. Final confirmation of the existence of dark matter appeared to come from observations of the small variations in the temperature of the cosmic microwave background. Under current theory, this is the glow left over from the big bang, when the temperature of particles had cooled enough for atoms to form, and light was first able to escape. Simulations showed that the variations were not large enough to have coalesced under gravity into galaxies and clusters of galaxies, similar to those observed, within the time available since the big bang. Again, five times the amount of dark matter as matter was needed to provide sufficient gravitational attraction. However, such non-interacting matter was unexpected within the Standard Model of particle physics and, despite extensive searches, has not been detected except by its apparent gravitational attraction.

The second surprise came from observations of a class of supernovae (type 1a) that always explode when they reach a particular size. They can be used as standard candles whose brightness gives a direct measure of their distance at the time they exploded. This distance, out to galaxies more than 15 billion light years away, was compared with the expected distance indicated by the (Hubble) redshift of their host galaxy. Under General Relativity, this redshift arises from the expansion of "space" as the universe has evolved. This expansion is claimed to steadily stretch the wavelength of the emitted photons, and so their wavelength has been redshifted over the time taken for them to reach us. Gravitational attraction had been expected to slow the rate of expansion. However, when analysed assuming a constant speed of light and with space expanding at a rate dependent on the energy/momentum density, the supernovae observations indicated that the rate of expansion had been increasing in relatively recent times. A new, unknown form of energy – "dark energy" – was hypothesised as the cause of this "accelerating expansion". It appears to push galaxies apart more strongly as the empty space between them increases. Together, the two new hypotheses seemed to explain most observations if approximately 68% of the matter/energy of the universe is "dark energy", 27% is "dark matter" and only 5% is the ordinary matter of which we are made and can see and touch.

A recent addition to the list of ad hoc hypotheses has been that of an incredibly rapid initial expansion of the universe termed cosmic inflation. This has been hypothesised to explain the "horizon" problem. The observed uniformity of the large-scale distribution of distant galaxies and of the cosmic microwave background seems to require that the early universe was in thermal equilibrium. Yet distant galaxies in opposite directions to us are now so far apart that, for the current speed of light, they could not have interacted in the lifetime of the universe. It also sought to explain the "flatness" problem. If the geometry of space had deviated ever so slightly from flatness, then General Relativity predicts that its curvature would have been rapidly amplified over time. Yet, it is observed to be very close to flat, that is, to have zero curvature, just in the recent epoch of the universe when we happen to be around to measure it.

Cosmic inflation proposes an exponential expansion of space in the early universe. The hypothesis is that the universe expanded by some 20 orders of magnitude (10^{20}) between the first 10^{-36} to 10^{-32} seconds after the big bang. This incredibly rapid expansion, much greater than the speed of light, locked in the initial uniformity. Following the inflationary period, the universe continued to expand, but at a slower rate. This proposal was initially treated with much scepticism. How could the entire contents of the universe expand faster than the speed of light when Special Relativity says that accelerating just one electron to this limiting speed would take infinite energy? However, the proposal has since been widely accepted and rewarded [19]. It is claimed that such an expansion is possible because “space is not a thing”, it is a relationship [20]. The galaxies are not moving; it is the empty space between them expanding!

The realisation that the gravitational redshift arises from changes in stored energy when the speed of light increases, and mass per unit matter decreases, overcomes the need for these ad-hoc hypotheses. It replaces the idea that the redshift of distant galaxies arises from either a Doppler shift or from an expansion of empty space. The redshift of distant galaxies instead arises from a steady decrease in the energy held per unit matter, when the speed of light was faster going back in time, i.e. earlier in the history of the universe. A faster speed of light means that the light emitted earlier will have travelled further in the time that it has taken to reach us. Correcting for this effect (see below) completely removes the discrepancy between the distance based on brightness and distance based on redshift. The evidence for an accelerating expansion is completely removed. In fact, the evidence for any expansion at all is removed. The change in energy (redshift) is fully explained by the change in speed of light. Matter will have held less energy in the past, and identical atomic clocks will have run more slowly (the frequencies of all their transitions will have been lower). However, there is no matched distortion of space, just an apparent increase in distance travelled by the light earlier in history. The horizon and flatness problems disappear and there is no need for cosmic inflation. “Space” is the fixed separation between objects not in relative motion. It is not a magic essence of emptiness, or just a relationship, that can expand without objects moving. The idea that the entire contents of the universe could move apart much faster than the speed of light never made sense. A distance scale cannot expand and it would take infinite energy to accelerate just one electron to the speed of light.

Another “dark” issue is that the presence of singularities inside “black” holes should be seen to establish that General Relativity is either wrong or has been pushed beyond its limits of validity. It has gravitational attraction of massless photons arising from their momentum. As a result, all energy and momentum must distort spacetime. When the density of mass/energy is small there should be negligible distortion. Spacetime then becomes increasingly distorted as the mass density increases. The increasing distortion gives rise to additional gravitational acceleration with its associated kinetic energy and momentum, which then gives rise to more distortion. This positive feedback mechanism is what gives rise to putative singularities inside black holes. They become inevitable once a critical density is passed [21]. Full Relativity has the mass per unit matter decreasing as local density increases. This is a negative feedback. The gravity from the same quantity of matter decreases, preventing the infinity. Thus, Full Relativity also removes the unphysical singularities at the centre of black holes.

The fact that a photon does not lose energy in escaping a gravitational field also means that black holes do not trap light behind an event horizon. This does not mean that extreme concentrations of matter, giving apparent black holes, do not exist. However, the wavelength of light is not shifted after emission by a gravitational field. The energy of atoms in a black hole is shifted far into the red and any radiation can also be trapped by bending. The observed black shadows (the famous images of black holes at the centre of our and another galaxy) can still arise from the gravitational bending of light.

Under General Relativity, nothing travelling at the speed of light can cross (outwardly) the claimed event horizon of a black hole. However, it is observed that gravitational attraction moves when the massive source moves and that changes in strength and direction propagate at the speed of light [22]. Once General Relativity’s claimed horizon has formed then no changes in the location, strength, or movement of the mass inside the event horizon should be sensed or observed by an external observer or object. Hence, just like light, gravity and changes in gravity should be trapped. However, under Full Relativity, gravitational potential does not carry energy and should not be redshifted. These differences allow stars and black holes to rotate around each other. Up until now, this inherent problem has been ignored by assuming the distortion of spacetime not only remains but can also move.

Dark energy not required

Under Full Relativity, empty space cannot expand and the energy/momentum held by matter (mass) reduces as the speed of light increases. [A hidden assumption, discussed below, is that inertia is constant as it affects the relationship between energy and momentum.] Thus, all atoms are blueshifted by the opposite amount to the supposed redshift of photons. This necessarily means that their emitted wavelengths decrease, and the Compton frequencies of their transitions increase, consistent with the increase in stored energy (mass). Hence, the same matter (in an otherwise unchanged background) holds less energy as the local density of matter and speed of light increase.

However, Full Relativity has the $1/R$ dependence of gravitational potential arising from opposing chiral components. If just one chiral component increases, when there are equal chiral contributions, then the increase in the speed of light will be only half that which would occur if both components increased by the same total amount. The mass per unit of matter therefore reduces by half the amount that would occur if there were equal increases in both chiral components. For a distant location the mean distance and amount of like matter is unaltered by clumping but its contribution to the speed of light will decrease. This will happen for contributions in regions of both matter and antimatter. The speed of light will therefore decrease because clumping reduces both components of the background over time. There will be a net increase in mass per unit matter and an increase in asymmetry and therefore inertia. Rotating galaxies should therefore contract until gravitational forces are balanced by centripetal forces with inertia increasing towards galaxy centres. The mass per unit matter should increase by the same fraction as c decreases due to the total background decreasing with time.

This argument needs critical evaluation. However, it implies that looking back in time, the speed of light will have been faster and the asymmetry between the contributions from matter and antimatter to the background potential will have been smaller. This asymmetry will have increased and the speed of light decreased as "matter" separated into regions of opposite chirality which are now gravitationally isolated. This should give a steady reduction in light-speed and a matched opposite increase in the energy held per unit matter as the universe evolved.

Under Full Relativity, the speed of light at the time of emission will have been proportional to the ratio of wavelengths (inverse of trapped momenta) of the same transitions of the emitting atoms (λ_{em}) relative to those received now (λ_{rec}). So a redshift of one ($\lambda_{em} / \lambda_{rec} = 1 + Z = 2$) means that the speed of light will have been twice as fast. The light will therefore have travelled further by a factor proportional to the integral of $1+Z$ over the time since emission, i.e. by $Z(1+Z/2)$. Thus the distance data versus Z , determined from supernova brightness, must be divided by $(1+Z/2)$ to give the time that light has taken to travel from the supernova.

The publicly available data from the Dark Energy Survey (DES) [23] is plotted in Figures 1 and 2. The raw distance data (blue squares) is shown in Fig. 1, together with the corrected data (green circles). The upward curve in the raw data, indicating distant supernovae were fainter than expected, led to the claim that the rate of expansion of the universe was increasing. The adjusted distance allows for the speed of light steadily reducing over the travel time since emission. The corrected data, with error bars, for just the supernovae with a high probability (Prob. > 0.67) of being type 1a are plotted in Fig. 2, along with the additional set of reference nearby supernovae (yellow circles). The weighted least squares fit to the data takes into account the estimated distance errors. The displayed plus and minus errors are based on the quoted error of the distance moduli converted to increased and decreased distances then reduced by the factor $(1 + Z/2)$ to convert to travel time.

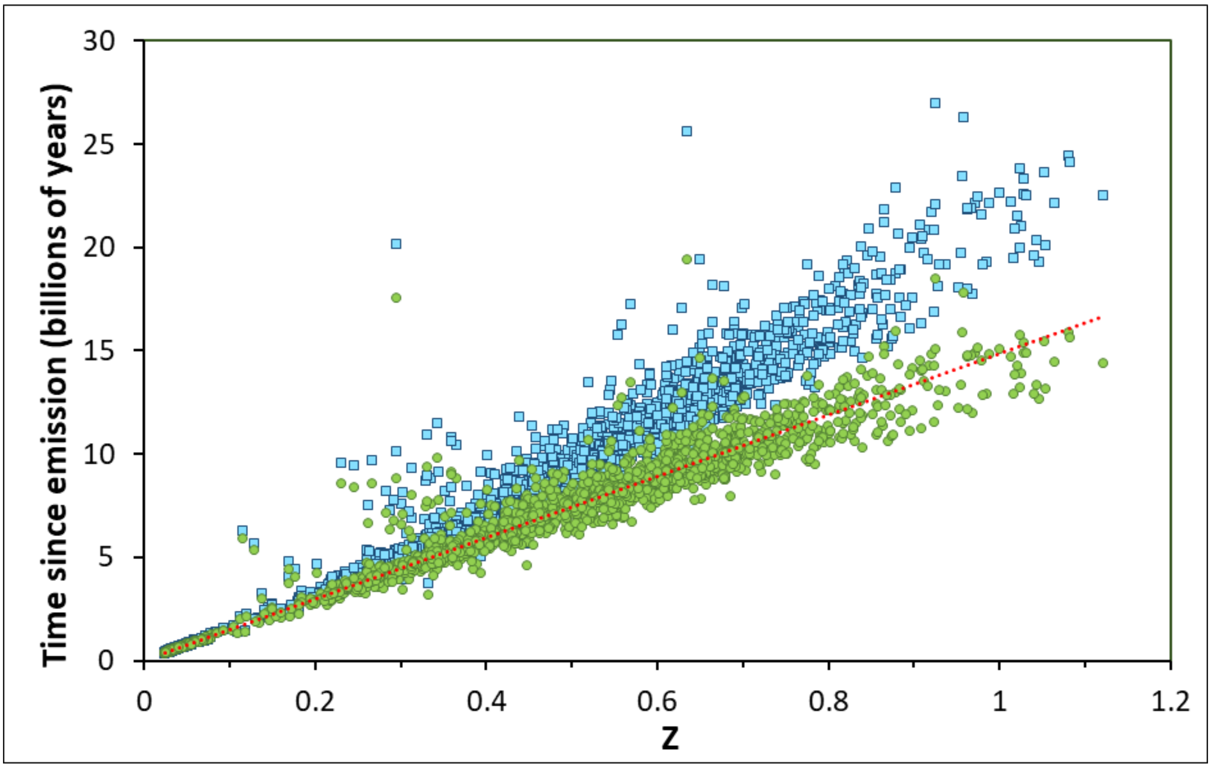

Fig. 1 Raw data (blue squares) and corrected data (green circles).

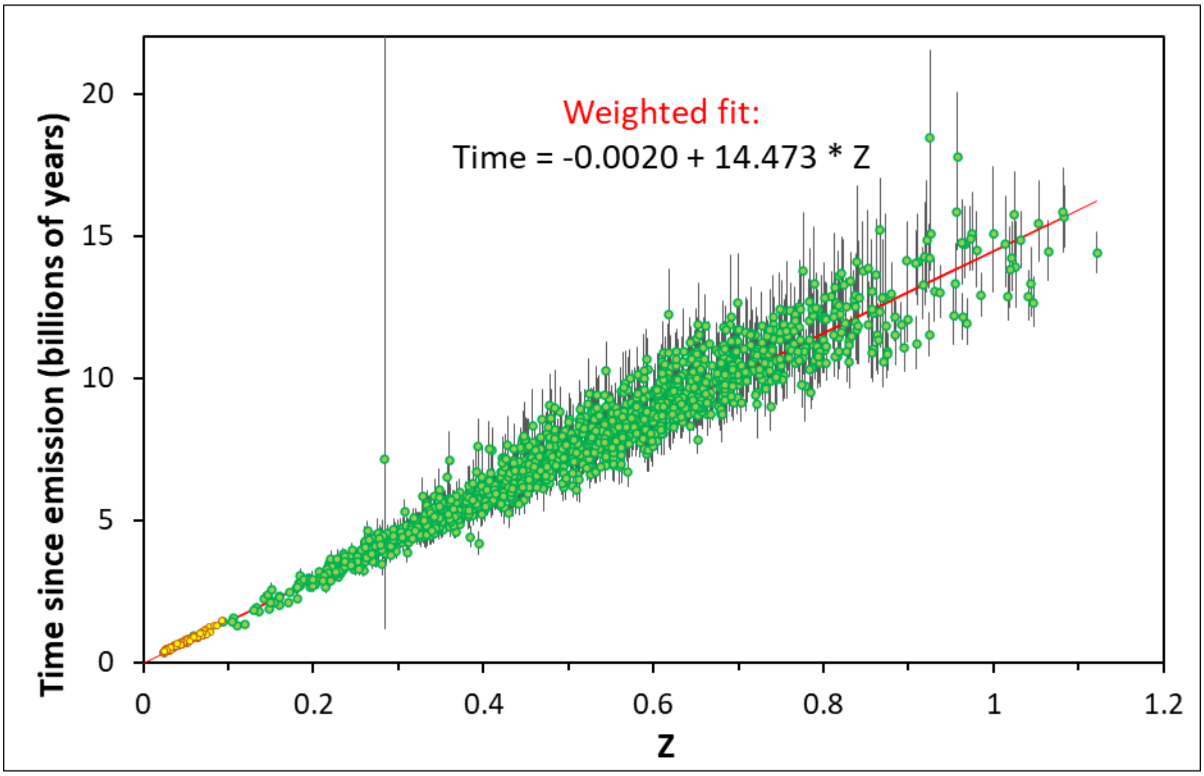

Fig. 2 Corrected data with error bars (and prob. > 0.67 that Type 1a).

The conclusion is that the correction removes any accelerating expansion. Moreover, the constant slope strongly suggests there is no need for any expansion and therefore for a big bang. The weighted fits of the DES supernovae with or without the additional low redshift supernovae (yellow) are the same (Time = $-0.00002 + 14.4732 * Z$ and $-0.0020 + 14.4728 * Z$). Both fits accurately pass through the origin. Thus, the observational evidence is that the cause of the Hubble redshift is the lower energy of matter at the time of emission. There appears to be no reason to posit any expansion. The data appears to be consistent with a non-expanding distribution of galaxies that is uniform on a large scale. It appears to have separated into regions of gravitationally isolated matter and antimatter in which galaxies are clumping together over time. The average mass/energy per unit matter has increased and the speed of light steadily decreased over time. An initially hot, dense universe that cooled by expansion is not required and wavelengths are not stretched by the empty space between objects expanding from an initial singularity. The data appears consistent with the energy held per unit matter having doubled over the last 14.473 billion years (of current time) and the speed of light having halved.

Full Relativity implies that the rate of the fractional change in mass of matter is a halving of the current value in 14.47 x 10^9 years. This amount is significantly less than the error on the value of c at the time its speed was defined as constant in terms of the length of time of 9192631770 cycles of the radiation emitted by a caesium-133 atom in a transition between two specified energy states.

The supernovae result is consistent with the earlier Union 2.1 data (Fig. 3) [24], which covered a wider range of Z values (out to 1.41) but with far fewer supernovae and somewhat increased errors. However, the slopes [(Time in billions of years)/ Z] are similar (14.473 in Fig. 2. and 14.535 in Fig. 3).

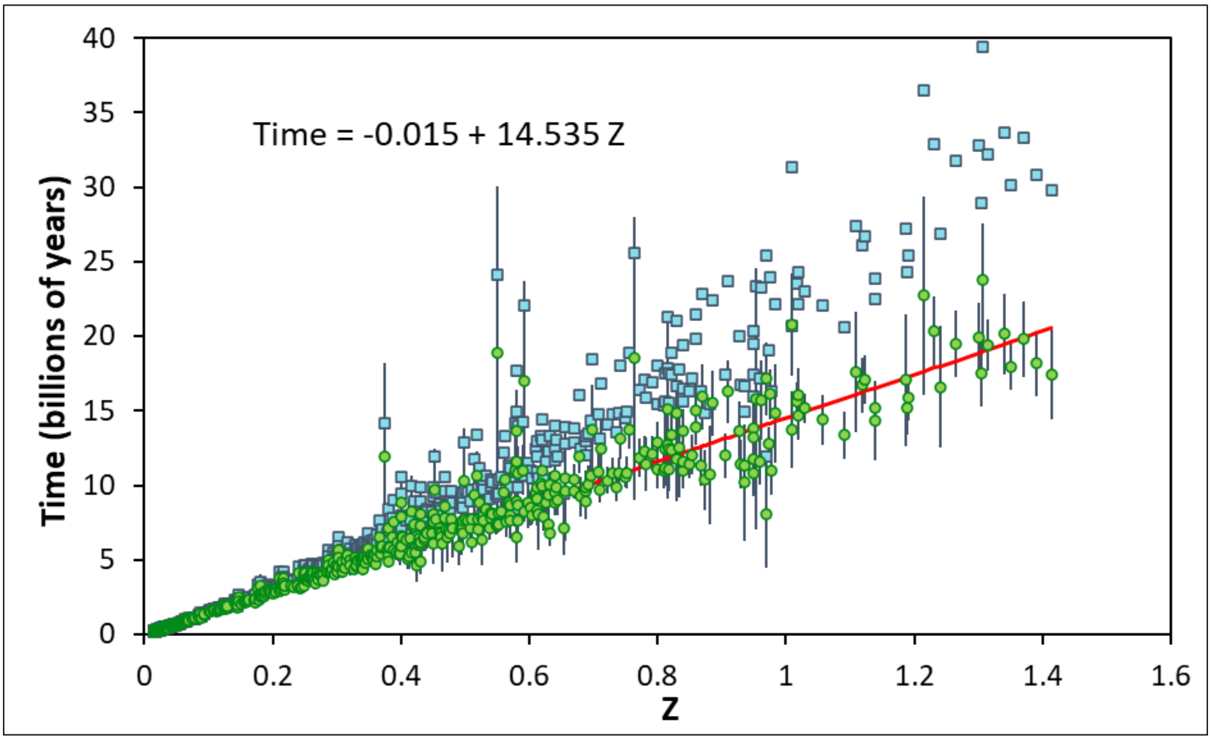

Fig. 3. Union 2.1 data, raw (blue squares), corrected (green circles), with least squares fit.

An apparent dark energy is predicted

Full Relativity not only removes the presence of an accelerating expansion but also predicts that the faulty assumptions of General Relativity will necessarily lead to the appearance of an apparent dark energy. The effect of local clumping of matter (i.e. increased density ρ) is to reduce the mass per unit matter. This means that the derivation of the differential, or Poisson, form ($\nabla^2\Phi = 4\pi G_N \rho$) of Newton's equation, on which General Relativity is based, does not hold. The derivation assumes Gauss's law for a conserved flux (see Appendix A). However, the flux due to mass from a constant amount of matter is not conserved. It reduces as the density of the enclosed matter increases. A necessary consequence of this mistaken assumption is that General Relativity's equation predicts that an increase in volume, of a fixed amount of matter, will lead to an apparent repulsive force.

Under General Relativity's assumptions, an apparent dark energy must appear if the universe is expanding. The amount predicted will be that needed to produce a flat spacetime, because empty space (distance) cannot be distorted. Under GR, an expanding universe requires an apparent repulsive gravity (dark energy) whose magnitude depends on the increase in empty space (reduction in density). This explains why General Relativity's ΛCDM model (that incorporates Einstein's cosmological constant Λ and Cold Dark Matter) can appear to fit observations. The cosmological constant was introduced to achieve a flat, non-expanding universe.

Dark matter potentially solved

The decrease of frequency and inertia with decreasing chiral asymmetry means that inertia will decrease away from the centre of an isolated galaxy (of just matter or just antimatter). However, it will be almost constant within our solar system (miniscule in size relative to the galaxy). Asymmetry, and therefore inertia, will reduce with distance from the centre of an isolated galaxy giving rise to an apparent increase in the strength of gravity. This appears able to explain the flat rotation curves of galaxies, when inertia decreases at the same rate as the gravitational force once outside the near field.

The relationship between inertial and gravitational mass will vary with position in a galaxy. Thus it is likely that the mass of our galaxy based on the apparent or assumed strength of gravity closer to the centre of a galaxy and its black hole is underestimated. The speed of stars rotating around the central black hole of our galaxy are assumed to have the inertia characteristic of the location of our solar system. Under Full Relativity the inertia will be much higher leading to a significant underestimate of the mass of the black hole and of our galaxy. The changes in light-speed and inertia can then explain both the flat rotation curves of spiral galaxies and gravitational lensing, without dark matter.

The revised understanding voids the claim that the distribution of matter, and supposed dark matter, seen in the Bullet Cluster (1E 0657-56) of two colliding galaxy clusters, constitutes a "direct empirical proof" of the existence of dark matter [25]. It is claimed that the bulk of hadronic matter is at the location of the visible plasma while the gravitational bending indicates that the location of the centres of gravitational attraction are at the centres of the galaxy clusters, which is where the (electromagnetically) non-interacting dark matter should be expected to reside. The suggestion that the plasma should indicate the location of the dominant source of mass appears to be based on tenuous evidence. Most of the stars should pass through unless the cores of the galaxies actually collide. More importantly, the inertia of the cores of the galaxies (any region with asymmetry significantly larger than that in our solar system) will be much larger than expected using our value for G_N . Their momentum will be correspondingly greater for a given velocity.

The larger than expected momentum for a given velocity will alter the apparent dynamics and clusters of galaxies of like matter will also give rise to gravitational lensing that depends on the surrounding galaxies and not just the enclosed matter. It is highly desirable that the observed gravitational lensing be fitted using the revised theory to confirm that dark matter is also no longer required to explain the observed lensing.

Further consequences of changed interpretations

The understanding of cosmological observations is greatly changed under Full Relativity which enables many other apparent problems to be resolved.

The claimed expansion of the universe seen in the Hubble redshift of distant galaxies cannot be attributed to a Doppler shift, nor to an ongoing expansion of empty space that stretches the wavelength of light, but not massive wave-particles. The geometry of space is always flat (not curved). There is no evidence that it is flexible or dependent on matter or energy density.

Cosmic Microwave Background

Under General Relativity, the nearly uniform background radiation at microwave wavelengths, from all directions in space, is the remnant glow from the big bang. It is claimed to be photons released (freed from electromagnetic interactions with charged particles) when the initial hot dense state cooled sufficiently for neutral hydrogen atoms to form. The photons have been subsequently redshifted by the supposed expansion of the space. Under Full Relativity, the much lower frequency reflects the much lower energy held by atoms at the time of emission. Photons, with no mass have an unchanged energy after emission. It is massive objects that change. The empty spacetime between them cannot expand and thereby stretch light but not atoms (i.e. other wave-particle states).

Hubble Tension resolved

The “Hubble tension” refers to the discrepancy in the expansion rate of the universe, as seen in the different values of the Hubble constant determined from observations of the early universe and of the late (i.e. recent) universe. An extensive up-to-date collation of the discrepancies between methods of determining the current value has been published [26]. The most significant and persistent discrepancy between measurements obtained from early- and late-time cosmological probes, is said to challenge the completeness of the standard ΛCDM model and suggests the possible need for new physics. Early Universe constraints, primarily from the Planck satellite, which maps CMB anisotropies, provide a value of $H_0 = 67.4 \pm 0.5\ km\ s^{-1} Mpc^{-1}$. Late-time measurements, primarily based on the distant ladder using Cepheid variables and Type 1a supernovae data yield values around $H_0 = 73.2 \pm 0.9\ km\ s^{-1} Mpc^{-1}$. A discrepancy of 5 to 6 σ.

The constant slope (Fig. 2) of the supernova fit (14.473 billion years per unit Z) yields a value for the Hubble constant of $H_0 = 67.56\ km\ s^{-1} Mpc^{-1}$ (with a statistical error ≤ 0.01), as the apparent current rate of expansion. This is in very good agreement with the early-time data. The reason appears simple. Currently cosmological data (uncorrected for changes in the speed of light) is interpreted under General Relativity’s ΛCDM model. This model incorporates the faulty assumption of a space whose scale changes with matter and energy density (including dark energy) and curvature (k), i.e. $H(z) = H_0 \sqrt{(\Omega_m (1+Z)^3 + \Omega_\Lambda + \Omega_k (1+Z)^2)}$ [27]. The early-time data is able to constrain the fit to the asymptotic slope at low Z passing through the origin. The fit to the late-time data assumes that, at values of $Z \simeq 0.8$, there will have been a transition to a deceleration phase cancelling the wrongly postulated recent accelerating phase used to explain the unexpected faintness of supernovae. This allows a steeper slope (larger H_0) to provide a reasonable fit to the data, particularly as the error bars grow with Z. The removal of the disagreement confirms that the density-dependent correction factors in the ΛCDM model, due to an expanding space, are not required.

Horizon and Flatness problems avoided

Full Relativity also removes the “horizon” problem, because space is not expanding and the speed of light was faster in the past; hence going back further in time ever larger volumes would have been in contact and in equilibrium via radiation. The "flatness" problem is avoided because the geometry of space has always been flat (Euclidean). It only occurs under the hypothesised curvature of space. The feedback mechanism of General Relativity means that both gravity and dark energy should rapidly inflate even the smallest amount of curvature, pushing spacetime's geometry away from flatness. Yet the universe is currently found to be flat.

An equal quantity of antimatter

Full Relativity's explanation of gravitational lensing and galaxy rotation curves via inertia requires nearly equal backgrounds from matter and antimatter. It has the speed of light much faster and inertia and mass per unit matter much smaller early in the evolution of the universe. This would seem to have led to rapid annihilation of any matter with antimatter for which the components of velocity towards each other were strong enough to overcome the small gravitational attraction. Full Relativity therefore proposes that the apparent dearth of antimatter is because most of the matter in opposite regions annihilated until they became separated into interlaced regions of gravitationally bound like-matter. The mass of the matter increased as the speed of light slowed and the clumping of like matter increased over time, as the Universe evolved. This led to the formation and contraction of galaxies as inertia increased, which maintained the separation of matter and antimatter. Therefore, the presence of the antimatter regions is no longer revealed by annihilation.

Photons can cross freely between regions of matter and antimatter. Neutrinos would be expected to convert to the opposite chirality. It is not that antimatter is not present. The overall totals are matched, in line with the observed symmetries of interactions and properties, seen in observations and the theory of the Standard Model. It is just that, unless significant quantities annihilate, there is no signal to establish that antimatter is present. However, it seems to offer a plausible explanation for the $1/R$ dependence of gravitational potential and other observations.

Big bang nucleosynthesis

The relative abundances of light elements has been put forward as strong evidence for a big bang. This is because of the requirement that there were sufficient photons to baryons and that the universe was hot enough for protons and neutrons to transform into each other easily. Their ratio, determined solely by their relative masses, is then about 1 neutron to 7 protons giving a primordial abundance of about 25% helium-4 by mass, as observed. Full Relativity, however, has the energy of protons and neutrons much lower and the kinetic energy (heat) can come from the annihilation of most matter and antimatter. This appears to be a plausible scenario subject to detailed modelling.

Baryon acoustic oscillations

Under General Relativity, these are claimed fluctuations in the density of normal (baryonic) matter caused by acoustic density waves in the hot plasma (electrons and protons) of the early universe. Their length scale is given by the distance the acoustic waves could travel in the plasma before it cooled enough for neutral hydrogen atoms to form. The photons could then travel freely without being absorbed. This recombination happened at about 3000 °K, when the universe was around 379,000 years old, or at a redshift of Z = 1089. At this age, the size of acoustic bubbles were 450,000 light-years in radius (490 million light-years today divided by Z = 1089).

Under Full Relativity, the early universe was not hot and the wavelengths of photons have not been stretched. The apparent redshift comes from the lower mass (reduced stored energy levels) of the atoms. The speed of light was, instead, about 1089 times faster when the mean free path of the photons was short enough that recombination could occur. If this is correct, the principle (i.e. combination into atoms allowed radiation to escape) and the prediction of the size of "temperature" fluctuations may be the same but the explanation is different. The variations in wavelength come from differences in the degree of clumping when a region began to let radiation escape.

Future tests and opportunities

There are clear differences in predictions, and explanations, that allow both logical assessment and experimental or observational tests that distinguish between the new and current perspectives. A yes/no difference between the theories of gravity is in the apparent versus real distortion of distance. This can be tested by examining direct timing signals (using on-board clocks) and returned (reflected) signals to Earth from spacecraft with increasing measured distance from the Sun. A re-examination of the data from the Pioneer spacecraft or a new experiment where heat radiation is uniform may help.

Perhaps the most straightforward test is to establish whether it is movement relative to the observer or movement of the observer relative to the background that slows time. It should be possible to compare very low mass but accurate clocks moving linearly towards each other and to a central clock (or spaced pair of clocks) at a very high, but constant, velocity and compare all clock-rates after allowing for movement during the transmission time of signals. This needs to be done in space, i.e. at high vacuum, with lengthy initial acceleration and a nearly constant gravitational potential.

The forthcoming much more extensive data from more distant Type 1a supernovae ($1 < Z < 2$) should be tested to see if a variable speed of light continues to remove any need for expansion. It should also provide a more accurate determination of the current rate of change of time. Data from the James Webb telescope may provide evidence for the expected contraction in the size of galaxies over time. A test for asymmetry of matter/antimatter as the source of inertia would be the dependence of inertia on position within our and other galaxies. It should be visible in the expansion rates of the matter in supernovae explosions. The expansion rate should reflect the inertia seen in the galaxy rotation curve at the supernova location.

The expected effects of changes in inertia and mass on the motion of galaxies within clusters, on the development of galaxy structure with time, and on the rise and fall times of supernovae light curves (as a function of position within galaxies) need further investigation. The changes in mass and inertia might then be tested as an explanation of the observed radial acceleration relationship of vastly different galaxies [28]. Full Relativity might also explain the Tully-Fisher relationship between the asymptotic speed of galaxy rotation curves and galaxy luminosity and why Modified Newtonian Dynamics (MOND) appears to explain galaxy observations better than dark matter halos.

Modelling and observations which could quantify the local magnitudes and degree of asymmetry between matter and antimatter contributions would be most desirable. This should make it possible to relate to the value of Planck's constant to Newton's gravitational constant and, ultimately, to the masses and interaction strengths of all wave-particles.

Discussion

It is interesting to step back and try and understand why spacetime and General Relativity were so readily accepted by so many. Up until a few years before their appearance physics appeared to be just about establishing behaviour to greater accuracy. Then, some unexpected results came in. These included observations that electrons and light had both particle and wave properties. Einstein found that light waves came in lumps, while others observed that beams of light could interfere like waves. It was also observed that the speed of light in vacuum was independent of the speed of the source, but was sensitive to the direction and speed of flow in a liquid. However, experiments also showed that there seemed to be no effect of the speed of Earth's orbit on the medium needed to carry light waves. In addition, it was observed that the difficulty of bending charged particles in electromagnetic fields became more difficult as their speed increased.

Special Relativity appeared attractive because it seemed to solve the problem of why the speed of light in vacuum should be fixed independent of the speed of the source yet light travelling through a flowing liquid was carried faster. Einstein noted, as Galileo had observed for someone below decks on a ship, there appeared to be no dependence on motion relative to the shore. He proposed that, for any speed, the laws of physics were independent of an absolute speed relative to any background. Instead, the observer's perceived distance and time were altered by relative movement, but in a way that kept the speed of light fixed. Einstein's initial claim that a background medium was therefore superfluous appeared to be helped by the understanding that photons were self-propagating oscillations between an electric and a magnetic field. Minkowski came up with a formulation of the mathematics of Special Relativity based on a conserved interval – the square root of the sum of altered squared intervals of space and time. Light-speed was kept constant in the absence of gravity.

Einstein was then able to introduce conserved intervals of a distorted spacetime in General Relativity. This distorted geometry kept the speed of light constant for an observer at the same gravitational potential, provided any gradient in potential was small enough to be ignored. He initially did this by claiming that, because a freely falling observer felt no gravitational force, gravity was transformed away. It was no longer present in the sense of any effect being observable. This tied in with the observation that the acceleration of all objects was independent of the nature of matter. It led to the claimed Equivalence Principle that the laws of physics were the same for a stationary observer in a gravitational field and an observer undergoing a matched constant acceleration in the opposite direction. The field of gravitational acceleration arose from a variation in the density of energy and momentum, so any acceleration could also be attributed to a distortion of the fabric (geometry) of a four-dimensional spacetime. Under Full Relativity, these claims are faulty (see Appendices).

The first faulty assumption in Special Relativity was that the clocks of a moving system keep the same time as those of the stationary system, independent of the speed of any steady motion. This only holds in the limit of low speeds relative to the background field from matter/mass. It was followed by the failure to take into account the effect of movement of objects during the time taken for signal transmission. Other mistakes then allowed a faulty interpretation of the meaning of, and restrictions on, the length and time coordinates in the Lorentz transformation. An inversion in the meaning of time intervals relative to distance intervals allowed the increase in apparent speed of light to be cancelled by an unneeded contraction in distance to keep light-speed constant. However, the speed of light is necessarily constant within a region of constant mass density. No distortion of distance, labelled as 'space', is needed. The faulty Lorentz transformation allowed the incorrect claim that spherical radiation of light at the same speed was observed in both moving and stationary frames. These allowed the proposition that the perceived space and time was dependent on movement relative to the observer. Only their combination in a spacetime linked by a constant speed of light was fixed. However, the reality is that clock-rate is dependent on movement relative to the background and spacetime is an illusion. Moreover, there is no reason that the speed of light should have the same value for other constant regions independent of the absolute value of the mass density.

Thus, unjustified assumptions were a key part of the problem. What appeared true for a slow-moving human observer in one region of space and a particular period of time was taken to be true in all situations. The mathematics was then "tailored", and the evidence interpreted, to meet expectations.

A longer but similar sequence occurred for General Relativity. The overly generous assumption was made that what appeared true for a free-falling human observer in the local environment and time period was universally true. The flawed concept and mathematics of spacetime was absorbed into a framework that again had distance (space) distortable. In addition to malleability with speed of movement relative to the observer, spacetime was now malleable in proportion to the gravitational potential of the observer. The mathematics was then "tailored", and the evidence interpreted, to meet expectations. For both Special and General Relativity the needed critical examination was overcome or outweighed by the weight of peer opinion.

Full Relativity also needs critical examination, particularly in its more speculative hypotheses. The mechanisms involving the balancing of contributions from matter and antimatter, the trapping of momentum, and the relationship to wave-particle properties, all need fuller development. Hopefully, this will provide a path forward in understanding quantum behaviour and wave-particle physics.

Conclusion

The supposed fabric of spacetime in which distance and time are subjective and can be distorted by motion, while the measured speed of light is constant, comes from a faulty pair of hypotheses in Special Relativity. A speed of (massless) light that is independent of the speed of the emitting source does not require the measured speed to be independent of the speed of massive clocks and observers. Massive clocks moving at high-speed relative to a balanced background will tick more slowly and the apparent speed of the same light will appear faster. The magnitudes of the laws of physics will appear to depend on movement relative to the observer, but are, instead, dependent on movement relative to the background. Special Relativity only applies within a constant background. However, a fixed light-speed within a constant background does not need to be independent of the magnitude of the background. An observer using the slower time (local clock-rate) from movement relative to the background will observe events, that are stationary within the same background, as occurring faster. An observer using the clock-rate of the stationary frame will judge events in the moving frame as occurring more slowly. This reality was hidden by inverting the meaning of the change in time relative to the claimed change in distance, which is only an apparent change.

The invariant interval in which there are matched changes in space and time that keep the speed of light constant was taken over into General Relativity. Objects of constant mass are claimed to distort the scale of distance (space), as well as time, as a function of the difference in gravitational potential. Under Full Relativity, the clocks of observers at higher gravitational potential tick faster but distances are not altered. It replaces both Special and General Relativity. It has a background field from massive objects determining a variable speed of light. The mass held by objects is stored energy, and the amount stored reduces as the current local background due to massive objects and speed of light increase, but distances are unchanged. Gravitational attraction then arises from the fractional decrease in the energy held by matter when nearer other matter, rather than from an increase in the distortion of the fabric of spacetime but no change in light-speed or mass (at the object in a region of constant potential).

The reduction in the energy levels of the same matter then explains the slowing of frequency, and hence the slowing of time, deeper in a gravitational field. The apparent redshift of massless photons in escaping a gravitational field is, instead, a real increase (a blueshift) in the energy levels of the more massive receiving atoms. The energy and momentum of the photons are unchanged, in agreement with Newton's law of gravitation.

The increase in the local stored energy per unit of increased like matter, increases the local speed of light, but by a decreasing amount as the local matter to antimatter asymmetry increases as matter and antimatter both clump in the evolving universe. This means that the stored energy per unit matter was lower looking back in time while the speed of light was faster by the inverse amount (in the limit of a small asymmetry). Correcting for this effect removes the apparent "accelerating expansion" and hence the need for dark energy. Moreover, the local reduction in mass per unit matter (at the current, effectively constant, magnitude of the background) means that Gauss's law, used in deriving the differential form of Newton's gravitational equation does not hold. This equation was the basis of Einstein's gravitational equation. The change in the flux from a constant amount of matter with a change in density necessarily leads to an apparent, but non-existent, and therefore invisible energy. It was needed to make spacetime flat when General Relativity's universe is expanding. The remarkable coincidence, that it is currently flat when such flatness should be rapidly destroyed by gravity or dark energy, is removed. The geometry of spacetime is flat because the distance between objects cannot change without the objects being in relative motion. There is no need for an expanding universe, because galaxy redshifts with distance are explained by the decrease in energy levels with increasing speed of light looking back in time. There is therefore no need for an initial big bang or a rapid early cosmic inflation in which the "space" between objects can expand without the objects moving.

The "light" seen in the cosmic microwave background is not redshifted by an expansion of the space carrying the light. The much lower frequency reflects the much lower energy at the time of emission when hydrogen atoms could form (as inertia increased) and photon radiation could first escape. It is not definitive evidence of a hot big bang.

The introduction of a pair of chiral background components allows effects of the background to reduce more slowly (as $1/R$) with distance. This is why distant galaxies dominate and the background field is related to the gravitational potential, rather than to the acceleration field. The modest asymmetry in the contributions from matter and antimatter, that occurs within isolated galaxies, gives rise to resistance to acceleration (inertia). This, in turn, appears able to remove the need for dark matter by explaining galaxy rotation curves and gravitational lensing. It also explains the link between inertial and gravitational mass. Both depend on stored energy but asymmetry determines inertia.

Full Relativity needs further development and testing by experiments and in comparison with cosmological observations. However, just its accurate explanation of current observations that were claimed to establish an accelerating expansion of the universe, demands it be taken seriously. The simplicity of its ability to reproduce current predictions should be sobering for those who thought the evidence for the Equivalence Principle and General Relativity was overwhelming. Relativity's subjective reality that depends on relative motion and relative gravitational potential of the observer, and a space that can expand without objects moving, should never have been widely accepted.

The introduction of unusual, invisible, and previously unknown substances, such as dark matter and dark energy, after observations of unexpected behaviour, could have been treated with greater scepticism. The removal of the need for these and other ad hoc hypotheses, together with the avoidance of singularities inside black-holes and that gravity can cross their supposed uncrossable event horizons, is strong evidence for the validity of Full Relativity. In addition, unreasonable postulates, faulty assumptions, and logical errors in Special and General Relativity have been demonstrated together with how they can give rise to inconsistencies and apparent effects such as dark energy, dark matter, and altered distances without movement. Moreover, unlike General Relativity, Full Relativity is consistent with Quantum Mechanics and with the Higgs mechanism as a source of mass. It also appears likely to remove all current evidence for new physics beyond the Standard Model of particle physics.

For further documents on Full Relativity (although with some of the arguments and understandings superseded by this document) please visit: www.fullyrelative.com

Appendix A: The Consensus Model based on Relativity

In order to understand and appreciate the difference between the current and new theories we need to further outline the genesis of the current theory of gravity - General Relativity (GR). It is based on Einstein's earlier Special Relativity (SR), which applied to high-speed motion in the absence of a gravitational field. We will refer to these theories and their additions and interpretations as the Consensus Model. This is because almost all astrophysicists and theoretical physicists believe that there is overwhelming observational support for Relativity and its explanation of the appearance and behaviour of the universe arising from the structure of spacetime. Therefore, it is assumed that it's fundamental perspectives must be sound. Essentially all current models accept that GR based on spacetime is, on cosmological scales, the correct theory of gravity.

The most widely accepted explanation for cosmological observations is called the Lambda – Cold Dark Matter model (ΛCDM). It is a mathematical description of the nature and appearance of a universe that started with a sudden explosion (big bang) from an initial miniscule location. It includes the cosmological constant (Λ), initially proposed by Einstein to produce a steady-state universe, when his tensor equation required that the universe must either expand or contract with its geometry rapidly moving away from being Euclidean (flat). He later labelled this as his biggest mistake. However, it has now become the source of the unknown dark energy that allows the currently observed flatness. It also includes the postulated cold dark matter which only interacts gravitationally with ordinary matter. The model has the structure of a spacetime applicable to an isotropic and homogeneous expanding universe, that behaves like an expanding perfect fluid, with its geometry arising from the distribution of matter and energy.

However, at a deep level GR is known to be inconsistent with Quantum Mechanics and the Standard Model (SM) of particle physics which have provided even more spectacular agreement with experiment. Most physicists believe that the ultimate answer lies in the development of a Quantum Gravity that will alter GR at very small distances and high energies. This has led to enormous effort into to a search for physics beyond the SM. The unexpected dark matter and dark energy that constitute 95% of the universe, leaving only 5% for normal matter and energy, are considered to be prime examples of such physics. Their existence appears necessary, under GR, to explain cosmological observations but there is currently no room for them within the SM.

The new theory, Full Relativity (FR), instead argues that both GR and SR are fundamentally flawed. It is primarily the questionable assumptions behind the faulty concept of spacetime that has led to the belief in the existence of dark energy, dark matter and other claimed evidence for physics beyond the SM. However, it is necessary to examine the problems, the faulty assumptions, derivations, and conclusions in more detail. This will help set out a new path forward. The new perspectives already have observational support, and are open to further experimental and observational testing.

Introduction to Special Relativity

Einstein noted that the interaction of electric and magnetic fields depended only on the relative motion of the source and receiver. The observer could have either the magnet or the conductor stationary and observe the same induced current for the same relative motion. In electrodynamics it did not matter which one was moving. As Galileo had pointed out, an observer below decks on a ship did not seem to be able to tell whether they were moving relative to the shore. It did not seem possible to distinguish differences in behaviour according to which was moving. Einstein also noted that there seemed to be no evidence for the movement of the Earth relative to the "light medium". In addition, the speed of light appeared constant, independent of the motion of the source. These observations seemed to suggest that the phenomena of electrodynamics as well as of mechanics possessed no properties corresponding to the idea of absolute rest. The same laws of electrodynamics and optics seemed to be valid for all frames of reference for which the equations of mechanics held good.

Einstein promoted this conjecture based on two postulates (assumed facts). The first was the "principle of relativity" – that physical laws are independent of the speed of motion relative to anything. It was taken to be true that there is no way of telling which of object or observer is moving. This is a truly remarkable leap of faith. It claims that what you observe, for yourself and objects moving with you, is independent of your speed relative to all the rest of the matter in the universe, even if your relative speed approaches that of light.

The second postulate was that light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body. This was consistent with observations that the time taken to reach you does not depend on how fast the emitter is travelling relative to you or anything else. (This is not our daily experience. You have to allow for how fast a vehicle is moving if you want to work out the arrival time of an object thrown from the vehicle.)

However, because of the first postulate, this second postulate was subtly changed into the postulate that the <u>measured</u> speed of light is independent of the motion of the emitter <u>or observer</u>. This requires that time and space are subjective; the distance and time taken becomes dependent on your movement relative to the events. Only their combination into a constant speed of light is fixed. Under SR, relative movement between the observer and an object slows time and contracts distance. However, it claims that the time and distance for an observer moving with the object are unaltered, and that a second observer, moving relative to the object, would also see the first observer's time (their clocks) slowed and separation distances contracted. Observed, distance and time are claimed to be linked into a fabric of spacetime in which there are matched changes in the scale of space and time, along the line of motion. Movement of objects, including clocks, relative to the background is <u>assumed</u> to have no effect on clock-rate.

FR proposes that time is slowed by movement of objects (having mass) at high-speed relative to the background. The reduction in decay rates of unstable elementary particle (e.g. muons) at high-speed relative to the observer is taken as strong evidence for SR. However, the observations are for speeds close to that of light relative to us, and we are nearly stationary relative to the background. We can say this because the distribution of matter should have been much more even at the time the cosmic microwave radiation was released. The dipole asymmetry in the radiation from the cosmic microwave background should therefore indicate the current speed of the solar system relative to a uniform background. It corresponds to a Doppler shift of 370 km/sec [29], which this is only 0.0012 c . It would have a negligible effect on decay rates. Thus, movement relative to the background rather than the observer is not ruled out.

Problems with Special Relativity

SR has both the scale of distance between objects, and the scale of time flexible. Only their combination in terms of light-speed has a real existence. This has enabled a theory that has the laws of physics dependent on motion relative to the observer rather than to any background. Students happily accept that high-speed relative motion between observer and object will lead to apparent effects, because of the change in relative position during the time needed for signals to arrive. However, many struggle (rightfully) with the claim that time is always slowed and distances always reduced. This is opposite to the familiar concept of reciprocity. Normally, it is expected that if your clocks are running slower, then the other's clocks will appear to run faster, and the same objects measured using slower clocks will appear to travel further per unit time. However, this is not the case for SR. It is claimed that time and distance of events, perceived by the observer, depend on the magnitude, but not the sign (towards or away), of relative motion. It requires that space is just a relationship and not a fixed property. Its perceived value for each observer has the same alteration in proportion to their relative motion. This remarkable concept appears to have been accepted because of the use of the word "space", rather than "separation distance". "Space" seems to imply an amount of vacuum (a nothingness), whereas FR rejects this. The space between objects is the "concrete" property of a fixed distance between objects not in relative motion, independent of their speed relative to the observer.

The linkage of space and time into spacetime via a constant speed of light was initially set out by Minkowski [4]. He based it on the Lorentz transformation (LT) which had been designed to explain observations including the Michelson-Morley interferometer experiments [1]. These could find no effect of the Earth's movement on the speed of light. Lorentz proposed that the length of the interferometer arms must be contracted in the direction of motion. He had further proposed that larger intervals between ticks from motion relative to the aether, giving slower (dilated) time, matched the shorter distances travelled (length contraction), making the arm lengths appear constant.

This transformation (LT) had, by the time Minkowski presented his formulation, also been deduced by Einstein in SR. Einstein's thought experiment sought to relate the same events (locations in space and time) seen in a moving and stationary frame, with all values referred back to the stationary frame. Each frame is a set of spatial (x, y, z) coordinates with a time (t) coordinate based on having a clock at every point, with all clocks, stationary relative to each other, within that frame, synchronised. This means that if all clocks in the one frame could be examined at the one instant of time, or that their observed times were corrected for the time taken for the message to reach the observer, then they would show the same time.

The LT relates the coordinates of the same events seen by a moving (x', y', z', t') and stationary observer. For constant speed in the x-direction the transformation is:

$$x' = \gamma(x - vt),\ y' = y,\ z' = z,\ t' = \gamma(t - vx / c^2) \text{, where } \gamma = 1/\sqrt{1 - v^2 / c^2}.$$

The first problem is that Einstein's deduction of the LT claimed that all clocks moving at constant velocity, if stationary relative to their observer, would show the same time. This was based on his conjecture (the first postulate of SR) that the laws of physics (electrodynamics, optics, and mechanics) were independent of any constant speed of motion (not accelerating). This assumption demands that clock-rate is the same in all inertial (constant velocity) frames, and was inserted in Einstein's claimed derivation of the LT. Subsequent derivations have mostly used the principle of relativity - that all observers moving at constant velocity perceive the same results, including the same fixed speed of light – to obtain the LT. Again, the derivation assumes the answer.

Einstein's analysis claimed: "that light (as required by the principle of the constancy of the velocity of light, in combination with the principle of relativity) is also propagated with velocity c when measured in the moving system". This claim involves two assumptions. The first, is that the clocks of the moving system keep the same time as those of the stationary system and, secondly, that the measurement of position and velocity has taken into account relative movement during the time taken for propagation of the light between source and receiver. The observational requirement is, and was, that the (underlying) speed of light is independent of the speed of the emitting object. However, his analysis demanded that $c = x / t = x' / t'$ for light in both frames. The constancy of the observed speed was built into the derivation. This is faulty if clocks are ticking slower in the moving frame, but the distance scale is unchanged. It will mean apparent distance and measured speed are increased.

Einstein sought a relationship between an event with coordinates in a stationary frame (K) and the same event in a frame (k) moving with velocity v (denoted by primed coordinates). His derivation arrived at the LT. However, his derivation and interpretation of the LT has a number of problems.

He considered a ray of light, emitted from the origin of system k at time t'_0 along the x-axis to x', where at time t'_1 it is reflected back to the origin, arriving at time t'_2. These times are those in the moving system, so he claimed that $(t'_0 + t'_2)/2 = t'_1$ must hold. This equation was then used to deduce a relationship between the time of the moving frame and the time of the stationary frame. However, although events at time t'_0, t'_1 and t'_2 are stationary in the moving frame and can be synchronised in that frame, positions 0 and 2 are not the same location in the stationary frame. The average distance to their positions in the stationary frame is larger (by $[c/(c+v)+c/(c-v)]/2 = 1/\gamma^2$) than the distance at the time of reflection because of movement during signal transmission. The faulty equality missed including the change in timing due to the finite travel time of light (between originally matched locations in each frame) into the transformation. However, it led to a tentative transformation that was the same as the LT except for a velocity dependent scale factor $\phi(v)$.

He then performed a two-fold operation on this tentative transformation by applying it using $+v$ then again with the sign of the velocity reversed. He found that the result removed any time dependence of the coordinates and therefore concluded (wrongly) that the two-fold transformation had given a return to the stationary frame. In which case, $\phi(v) = \phi(-v) = 1$, yielding the LT. However, this is not correct. Using $-v$ is only the inverse transformation for the origin ($x = 0$). The procedure actually compares the coordinates of two frames moving away in opposite directions from the origin after initial coincidence. The two-fold transformation does not give a return to the original frame (as claimed). If time is found to be slowed in going to the moving frame, then time must be increased in returning. SR's claim that time dilation is independent of which observer is moving is faulty, and the inverse transformation is not obtained by replacing v with $-v$. Einstein's apparent deduction of the LT led him to the faulty conclusion that only relative motion between events and observer could be detected, not absolute motion. However, if time is found to be slowed in the moving frame, then time must be increased in returning.

Trouble with the confirmation and conclusions

Einstein sought to prove that any ray of light, measured in the moving system, has the velocity c, that it has in the stationary system. This would establish that: "the principle of the constancy of the velocity of light is compatible with the principle of relativity" [17]. The conclusion appeared to be confirmed because the LT converted $x^2 + y^2 + z^2 = c^2t^2$ into $x'^2 + y'^2 + z'^2 = c^2t'^2$. It was claimed that this meant that spherical radiation of light, at speed c, in the stationary frame is also observed in the moving frame (i.e. is seen by both moving and stationary observers). This is false. It does not correct the measurements for movement of objects during the transmission time of signals. It does not allow for: i) a slower clock in the moving frame meaning that the same light ray will appear to travel further; or ii) that the delays/advances in signal propagation times due to the relative movement of the frames become increasingly different for locations that were matched at $t = 0$. It is an artefact of having both x' and t' dependent on both x and t, so that cross-terms cancel, leaving x and t terms to be grouped.

Application of the LT to the primed coordinates gives:

$$x'^2 - c^2t'^2 = \gamma^2(x - vt)^2 - c^2\gamma^2(t - vx/c^2)^2$$

$$= \gamma^2[x^2 - 2xvt + v^2t^2 - c^2t^2 + 2vxt - v^2x^2/c^2]$$

$$= \gamma^2[x^2(1-v^2/c^2) - c^2t^2(1-v^2/c^2)]$$

$$= x^2 - c^2t^2 \quad \text{because } \gamma^2 = 1/(1-v^2/c^2)$$

Hence, $x^2 - c^2t^2 = x'^2 - c^2t'^2$ and it is assumed that $y^2 + z^2 = y'^2 + z'^2$, i.e. that the distortions of distance and time are only along the line of relative movement of the observer and events. Thus, it is claimed that light is always observed to radiate spherically independent of the speed and direction of the source emitting the light. This contradicts reality. If a burst of light is observed to reflect from a surrounding spherical surface moving at the speed of the emitter, the advances/delays (effects of altered distance to the surface at the time of reflection) must be taken into account.

Spherical radiation of light occurs independent of movement relative to the observer. The radius of the sphere will be doubled, if the clock-rate used is halved by movement relative to an approximately stationary background. The delays or advances in signal arrival time must first be applied to obtain the correct position of the source (at emission) after allowing for its movement during signal transmission. If the corrections are not applied, then the unobserved, but assumed, contraction of distance, plus the dilation of time give $x'^2 + y'^2 + z'^2 = c^2t'^2$.

The needed correction can be readily determined for a known velocity of relative motion, a known time of coincidence of frames, and a given constant speed of light. The separation is $\Delta x = vt$ if the events were coincident at $t' = t = 0$. The time taken to travel this distance is $\Delta x / c$, and the change in separation distance due to movement is $(v/c)(\Delta x / c)$. If x is taken to be the separation distance of locations which overlapped at time zero, then vx/c^2 is the time delay due to movement during signal transmission that must be subtracted from the observed time in the moving system. Inserting $x = \Delta x = vt$ into the LT gives $t' = \gamma t(1 - v^2/c^2) = t/\gamma$ and $x' = 0$ for all matched locations. However, if x is mistakenly taken to be the distance from the origin at $t = 0$ in the transformation to x', then an altered timing correction factor is needed in the transformation to t'. The factor must take into account the change in travel time due to the difference in advances/delays when the locations were not coincident at $t = 0$.

Thus, the alternate perspective is that the term vx/c^2 in the time t' of the moving frame is essential to correct for the advance/delay in the arrival time of signals (moving at c) when there is relative movement of v/c in the time x/c that light takes to travel the $x = vt$ distance interval between matched points. Hence, the time in the moving frame becomes: $t' = \gamma(t - v^2t/c^2) = t/\gamma$, which is consistent with a real slowing of time (fewer ticks of an identical clock) in the moving frame. The apparent distance between matched points in the two frames, according to the slower time in the moving frame, will then be $x' = \gamma(x - vt) = 0$ for $x = vt$. It applies to points that were coincident at $t = t' = 0$. Thus, every point in the two frames, matched at $t = 0$, has $x' = \gamma x$ and $t' = t/\gamma$, and moves apart at vt. The distance scale is the inverse of the clock-rate so that underlying speeds are unchanged. If an underlying reality exists independent of the motion of the observer, as should be expected, then the distance scale is not contracted (or distances multiplied by γ). It is only an apparent effect of a slower clock-rate (one in which intervals between ticks are larger by γ) so that $t/\gamma =$ less time on the slower clock. The interval $x^2 + y^2 + z^2 - c^2t^2 = x'^2 + y'^2 + z'^2 - c^2t'^2$, appears to be independent of which observer is moving, but arises from using x as both the interval between matched points in the expression for t', and as the fixed distance from the origin in the expression for x'. This is not allowed and forces a distortion of distance that changes sign for opposite distances from the origin.

The LT only applies for $\Delta x = vt$, so that a simplified transformation is necessary:

i) $x' = \gamma(x - vt)$, $y' = y$, $z' = z$, $t' = t / \gamma$, where x' is the apparent separation distance with time in the moving frame when the clocks of the moving frame are ticking more slowly; or
ii) $x' = x - vt$, $y' = y$, $z' = z$, $t' = t / \gamma$, where the underlying scale of distance is constant.

There is no need for the full LT to apply to the dynamics of massive particles. It holds for Maxwell's electromagnetic equations because massless fields always travel at the speed of light which is independent of movement relative to the background. In this case, only relative motion matters.

Acceptance of the full LT with its mixed interpretations of the meaning of distance and time coordinates is behind the formulation of SR (and later GR) in terms of supposed invariant intervals. It allowed distance and time to become malleable due to motion relative to the observer.

Allowing $\Delta x = vx / c^2$ to apply to locations other than the origin leads to a distorted distance and time. This is the mistake behind the claimed visual distortion and rotation of objects, passing at close to the speed of light, known as the Terrell rotation [30]. It is claimed that the differences in arrival times of signals reaching the observer from different parts of an object cancels SR's length contraction, making the contraction invisible. It is then claimed that a passing spherical object will still appear spherical but rotated such that you could see light from the far side! Only photons emitted in the direction corresponding to the relative location of the receiver at the time it will be received will be observed. The speed of light will be constant in the absence of a gravitational field so only photons whose difference in time taken matched the difference between emission time will be observed at any instance. Under FR, the non-existent Lorentz contraction of space arises from the failure to correct for movement during signal transmission. An apparent contraction (or elongation) only exists if there is no correction for movement during signal transmission, rather than that it is cancelled. If a sphere, emitting light in all directions, is moving directly towards or away from the observer then it will still appear circular but, if there was depth perception, it would appear flattened for movement towards and elongated for movement away. The apparent rotation of a passing object, comes from the changing viewing direction to the non-rotating object as it passes. Light cannot arrive from the other side of the sphere. The cancellation of the length contraction and the inversion to an apparent rotation traces back to the faulty equality used in Einstein's derivation and interpretation of the LT. The factor of $1 / \gamma^2$ needed to adjust for movement during signal transmission was split between an inverted change in time relative to the non-existent change in distance scale.

Einstein used the slowing of time to argue that a rigid spherical body must be foreshortened in just the direction of motion. The result was a contraction of distance that kept the speed of light constant. Time and shape/size had become subjective dependent on the relative movement of the observer. A side-effect is that the time and spacing claimed to be seen by every observer for another relatively moving frame and events, is non-linear. If the frames are moving apart at $x = vt$, then the clock-rate is $t' = t / \gamma$ (where $\gamma = 1 / \sqrt{1 - v^2 / c^2}$). Thus, a third observer midway between two oppositely moving clocks is required to see a smaller total slowing than the observers at each clock, due to the non-linearity of γ . Thus, reality has become malleable. Time of the same events is slowed, and distances are contracted, dependent on their speed relative to the observer.

The alternative that has been eliminated is that the behaviour of all massive objects, including clocks, is slowed by movement at high-speed relative to the background field from all mass in the universe. Observations of the slowed rate of decay of unstable elementary particles moving at high-speed relative to the observer have not yet distinguished between whether the slowing arises from (unaccelerated) movement relative to the observer or relative to a nearly stationary background in which the observer is in free-fall. However, the speed of massless light is independent of movement relative to the emitter, receiver, or the background field that conveys the photons.

The effect of high-speed movement (relative to the free-fall background rather than relative to the observer) has not been experimentally tested. The decay rates of unstable elementary particles slow with increasing speed, but this is relative to our clocks, and we are nearly in free-fall. We, and the Earth, will accelerate until the change in inertial mass with time, due to velocity, matches the gradient in gravitational potential with position. No net force is then felt. It does not appear feasible to send an instrument, with its own clock, at a high-enough speed to measure a change in the decay rate of approximately stationary unstable elementary particles. However, atomic clocks are stable enough to test the claimed non-linearity of the slowing of time with equal speed, but oppositely moving, clocks, and a clock at their stationary mid-point.

The basis of General Relativity

GR was built on Newton's universal law of gravitation and on the spacetime intervals of SR. In GR, Einstein sought to extend the idea that the laws of physics (at the object) were independent of motion at constant velocity (no acceleration) to also cover accelerated motion. He first took the Weak Equivalence Principle that the mass resisting acceleration (inertial mass) was the same property as the mass that determined gravitational acceleration (gravitational mass). This principle arose from the observation that all objects accelerate at the same rate, under vacuum, in a gravitational field. Einstein then noted that observers in free-fall felt no gravitation. The apparent universality led him to his "happiest thought" – "Since all bodies accelerate in the same way, an observer in a freely falling laboratory will not be able to detect any gravitational effect (on a point particle) in this frame". Or, "gravity is transformed away in reference frames in free fall" [31]. This invariance of the laws of physics, when no gravitational force is felt, is called the Einstein or Strong Equivalence Principle. The principle claims that physics in a frame, freely falling in a gravitational field is equivalent to physics in an inertial frame without gravity. Moreover, physics in a non-accelerating frame with gravity (e.g. standing still but feeling a gravitational force), is equivalent to physics in a frame without gravity but accelerating, by the amount expected from the same force, in the opposite direction. These should be seen as overly generous assumptions. Moreover, they cannot be based on a spacetime that is shown to be an illusion.

Einstein's belief in the Equivalence Principle also appears to have been based on the idea that physical laws should not depend on reference frames because these are arbitrary coordinate systems chosen by the observer. This had arisen because of the mistaken conclusion from the LT that observers would "see" and measure a constant speed of light. It seemed that space and time just expressed relationships in an empty space, only the speed of light was fixed. Thus it became accepted that "space is not a thing" [20]. However, the examination of the LT (above) shows that SR's claim that time dilation is independent of which observer is moving is faulty. FR has movement relative to the background dilating time and changing inertia. Directional properties, such as angular momentum, are conserved and linear motion (inertia) becomes more difficult with increasing speed. There is a difference depending on which frame, and how fast it is moving linearly, or rotating, relative to the background from all other massive objects.

The Equivalence Principle does not hold because the magnitudes of properties, such as mass and the speed of light, are affected by the background field from other matter that exists in seemingly empty space. The reality is that the observer in free-fall is continuously moving into a larger background which alters mass, inertia and light-speed. The observer feels no force because the force of gravitational acceleration is matched by the inertial force resisting acceleration. It is not that the force no longer exists. Gravity has not been magically transformed away. As objects move deeper in a gravitational potential they lose mass and light-speed increases. The Equivalence Principle is an unjustified, faulty assumption.

The equivalence of inertial and gravitational forces, independent of the material and of the direction of the gravitational field relative to any acceleration, appeared to be very strong evidence they are one and the same property. The universality of this equivalence was assumed based on the value of G_N appearing to be constant within our solar system and elsewhere. However, the matched masses in Eötvös experiments are compared together in time and location (on Earth). The equivalence arises because they both depend on stored energy and so are matched at the same location, time, potential, gradient in potential, and on any additional background property that has a negligible rate of change with time or location. Thus, if chiral asymmetry determines inertia per unit mass, but is effectively constant within our solar system, or changes in proportion to distance from the Sun, it will be absorbed into the local value of G_N. In distant star systems such changes will just alter the apparent value of the central large masses. In extended systems, e.g. galaxies, it will alter the apparent strength of gravity as a function of the mass distribution.

Einstein took SR's flat fabric of spacetime and allowed the strength of gravity from massive objects and their movement, and any form of energy/momentum, to distort its geometry. This distortion of the geometry of spacetime was related to the gravitational potential (Φ) of Newton's field equation.

Einstein's field equation is a generalisation of the differential form of Newton's field equation [32]:

$$\vec{\nabla}.\vec{g} = -4\pi G_N \rho \qquad \text{with } \vec{g} \equiv -\nabla\Phi \qquad (2)$$

It has the curvature of space-time and the differential (divergence) of the acceleration ($\vec{g}$) directly proportional to the stress-energy tensor. This tensor is the generalisation of mass density (ρ) to the density of energy and momentum. However, the hidden assumption in deriving the differential form (equation 2), and hence Einstein's equation(s) of GR, is that mass is independent of the surrounding mass density (see below). This is not the case under FR, because gravitational attraction arises from a fractional decrease in mass when mass density increases.

The derivation of the differential form follows from applying Gauss's law to the gravitational force law, as is done for electromagnetic fields [33]. The first step of the derivation is to equate the gravitational mass of Newton's universal law of gravitation with the inertial mass of his 2nd law ($F = ma$). This yields a vector gravitational acceleration "field" (force per unit mass $\vec{F}/m$) due to a point mass M of:

$$\vec{g}(\vec{r}) = -G_N M\hat{r}/r^2 \qquad \text{where } \hat{r} \text{ is the unit radial vector} \qquad (3)$$

This "field" (is the gradient of the potential field that reflects the influence of mass). It can be expressed, for an arbitrary mass distribution, as Gauss's law for the gravitational acceleration field:

$$\oint_S \vec{g} \cdot d\vec{A} = -4\pi G_N M \qquad (4)$$

The area integral on the LHS is the gravitational field flux through any closed surface S, and M on the RHS is the total mass enclosed inside S. However, constant flux through the enclosing surface assumes that the flux from an arbitrary distribution of matter is constant, independent of the distribution. This requires the mass of each component to be independent of the location of other components (as applies to charge). If mass is dependent on the background from surrounding matter, then this assumption does not hold.

If the flux is assumed to be constant, the divergence theorem, where the area integral is the volume integral of the divergence of a vector field, can be used on the LHS, and the mass on the RHS can be expressed as the integral of the mass density function ρ (i.e. $M = \int \rho dV$), giving:

$$\int \vec{\nabla} \cdot \vec{g} dV = -4\pi G_N \int \rho dV \qquad (5)$$

If this equality holds for any volume, the integrands on both sides must also be equal, giving equation 2. However, equation 2 does not hold because the mass (M) of the same amount of matter depends on the distribution of the matter within the volume. The density of the matter alters the mass held by a fixed amount of matter. This will alter the magnitude of the flux. The value of G_N will also require modification if the background affects the ratio of inertial to gravitational mass.

In GR, Einstein's replacement equation of motion expresses how the gradients in mass, energy, and momentum, distort space and time. It adds in the finite speed of light via the time taken for distortions of space to propagate. The geometry in which we live and unchanged objects exist, is distorted by massive objects in proportion to the divergence of the gravitational acceleration they induce. It is no longer the familiar space of three orthogonal directions, with equal length scales, and all clocks ticking at the same rate when not in relative motion. Objects are claimed to travel along the shortest (straightest) path in this distorted spacetime, even though those paths (such as planetary orbits) look curved to us. John Wheeler summed it up as: "Spacetime tells matter how to move; matter tells spacetime how to curve." Under GR, gravitational acceleration is not a real force. It is just the curvature of spacetime. The more massive an object the more spacetime is bent, which appears as a larger gravitational acceleration. Once an initial distribution of matter, energy and movement is set out, then Einstein's gravitational equation can be used to predict how it will evolve over time.

GR has been overwhelmingly accepted as fundamentally correct, because it is seen to have had many remarkable successes [34]. However, these predictions are based on a chain of shaky postulates. They can be shown (see earlier) to be faulty, or explained and derivable from alternate perspectives. Some, such as the original prediction of the doubling in the bending of light, appear to have been initially fudged [35]. Einstein's calculation in support of this doubling, published in English, after the observations of the changed apparent location of stars during the solar eclipse of 1919, is an altered version of one that pre-dates GR. The questionable calculation appears to have had an unexplained factor of two added. Subsequent calculations have all been based on GR's tensor equation(s) which have matched additive distortions of both time and distance [36]. A spherically symmetric metric (the geometry of spacetime) has two scalar functions (of changed time and distance scale). The (Schwarzschild) solution to the GR field equation yields $g_{00} = -1/g_{rr}$. Half the bending of light comes from the change in time giving a supposed loss of energy (redshift) in a gravitational field, and an additional half from a matched contraction of space. Einstein's field equations have inserted matched distortions of distance, in addition to those of time, based on arguments from the Equivalence Principle and the desire to keep light-speed constant at the location of the observer. However, General Relativity Predicts a solar deflection of a light ray that is twice as large as that implied by the Equivalence Principle [36].

The distortion of the geometry of spacetime by gravitational potential also means that cross-terms in the metric (matrix) involving both space and time can mimic the changes claimed by FR. The distortion of space corresponds to the change in distance travelled by light when the magnitude of the background field and light-speed change. GR's distortion of time can mimic FR's changes in clock-rate and energy with potential and motion. However, the apparent agreement is allowed by misinterpretations between space and distance, and time and time intervals.

There are also additional concerns. GR appears to be inconsistent with quantum mechanics, the theory of the very small, but its supporters trust that this will be eventually resolved by a theory of quantum gravity. It is also inconsistent with the SM of particle physics that links the other three fundamental forces. This theory has provided predictions of particle properties that are accurate to twelve significant digits. The one missing piece had been the Higgs boson, so the discovery of this particle was a major success. The theory does not require any further particles so there is no place for a particle that could explain dark matter. Under the theory, the interaction of the Higgs field with particles is in direct proportion to the mass which they acquire. Therefore, the underlying mechanism is a source, or the source, of the mass that gives rise to gravitational attraction, if Newton's law holds. This origin of mass seems difficult to reconcile with GR's conclusion that gravity is not a real force but a distortion of spacetime. However, the Higgs mechanism is consistent with FR.

It has been shown that Einstein's gravitational redshift derivation, and by implication, his bending of light calculation, "seems to be problematic", his derivations were "not without inconsistencies" and "heuristic" [10]. This seems to have the connotation of clever guesses or shortcuts that ultimately have led to the right answers. A different catalogue of Einstein's physics mistakes has also been published [37]. Ohanian concluded that "A century of such roadbuilding [i.e. improved analysis by subsequent physicists] has revealed that almost all of Einstein's seminal works contain mistakes. Sometimes small mistakes – mere lapses of attention – sometimes fundamental failures to understand the subtleties of his own creations, and sometimes fatal mistakes that undermined the logic of his arguments." However, these authors and almost every theoretical physicist have found it difficult or impossible to accept that the whole edifice could be found wanting after nearly 110 years.

Appendix B: Inversions of Meaning and the Conflict with Reality

Special and General Relativity (GR) are inconsistent with an objective reality that is independent of subjective experience. The lack of realism in their formulation has arisen from mathematics based on faulty physical assumptions or from misinterpretations of physical reality based on faulty mathematics. A consistent problem has been in the making of overly-generous or unrealised assumptions. It has been aided by carelessness in interpretation of the meaning of the words used, by missing the difference in meaning between intervals and magnitudes (of time and distance), and conferring a non-existent flexibility on the property of distance by labelling it as space.

Einstein's thought experiment, used to derive the Lorentz Transformation, sought to relate the same events (locations in space and time) seen in a moving and stationary frame, with all values referred back to the stationary frame. A priori, such a method cannot yield the time (clock-rate) of a clock moving (with speed v) relative to the stationary system because the clock is not being examined. The assumption made was that all clocks that were stationary relative to their observer would show the same time i.e. have the same clock-rate independent of movement relative to the background from massive objects. Yet, we know this background must exist because a gyroscope (in the absence of the rotation of massive objects) maintains a fixed orientation relative to distant stars. Moreover, we can detect the mean speed of our solar system relative to the distribution of matter at the time light first escaped from the early universe. Finally, we observe that high-speed motion of massive wave-particles increases their resistance to acceleration and slows the time of atomic clocks. An external reality in which these clocks were used to measure the speed of the same light ray would find that it travelled further per tick (intervals) of the slower ticking clock (larger intervals, time dilated).

If we accept that an underlying reality exists, independent of who or what is measuring and whether they are moving, then Special Relativity (SR) must be rejected. This is because SR has failed to take into account effects of movement on the measuring equipment and detection method. Einstein's supposed derivation of the Lorentz transformation (LT) was based on an equation that did not take into account the effect of relative movement during signal transmission. Taking the latter into account introduces a factor of γ^2 between perceived distance and time.

The transformation has time in the moving frame is $t' = \gamma(t - vx/c^2)$ while distance is $x' = \gamma(x - vt)$. Einstein argued that the transformation means that "a rigid body which, measured in a state of rest [$v = 0$], has the form of a sphere, has in a state of motion (viewed from the stationary system) the form of an ellipsoid of revolution" with $x' = \gamma x$ (i.e. the scale of the x-axis is increased by the factor γ). This appears consistent with keeping c constant if the scale of time is also increased ($t' = \gamma t$). However, the relative movement of the frames ($x = vt$) must first be applied as a correction for the change in arrival time of signals due to relative motion during transmission. The time in the moving frame must then be $t' = t/\gamma$. A change by the factor γ^2. It is now a decrease in the amount of time when viewed from the stationary system (so the moving clock is ticking more slowly).

Einstein's interpretation arrived at $x' = \gamma x$ and $t' = t/\gamma$. He then took $x = x'/\gamma$ as the length that objects of length x' (in the moving frame) will have in the stationary frame, so that the size (length) of moving objects appears shorter (FitzGerald contraction) in the stationary frame. On the other hand, he took the time (t') of a clock in the moving system as "nothing else than the summary of the data of clocks at rest in the system" [17]. This is the time at rest in the moving system. However, it leaves out the inversion used in interpreting lengths, which should have $t = \gamma t'$ being the size (amount of time) that moving time has in the stationary frame. Thus, $t' = t/\gamma$ was taken to be the time of the moving clock (in terms of the elapsed time in the stationary frame) and, since $t' < t$, time was slowed (less time occurred for the moving clock). The treatment of time relative to distance was inverted.

Minkowski [4] made a similar interpretation, that total time was $\int dt$, the sum of time intervals (the sum of data of clocks at rest in the moving system). If $t' = t/\gamma$ refers to time intervals (i.e. $dt' = dt/\gamma$) then the intervals between ticks of a clock in the moving frame are smaller and time is proceeding faster (more ticks than in the stationary frame). If $x' = \gamma x$ is also taken to mean $dx' = \gamma dx$, then the distance intervals of the moving frame should be larger than those of the stationary frame. Larger distance intervals should then mean that an object of the same length will appear shorter. Either way the inconsistency between the treatment of lengths and times allowed them to appear to change in unison keeping the "measured" c constant. However, a mapping in which time is slower (intervals between ticks larger) in the moving frame means distances intervals travelled per unit time interval will be larger. The original derivation arrived at $dt = \gamma dt_0$ and $dl = dl_0/\gamma$, where dt_0 and dl_0 are duration and length intervals in the rest frame, but then inverted their interpretation so that $c = dl/dt = dl_0/dt_0$. Thus the required factor of γ^2 from movement during signal transmission has been absorbed by an inversion of the changes in distance relative to time.

If the scale factor for time changes by $1/\gamma$ going from frame A to B, then an underlying reality demands that it must change by γ in going from frame B to A. A slowing of time that occurs independent of movement towards or away implies that the slowing is inherent to the movement and the changes in distance are apparent. The observed slowing of time (decay rates of unstable elementary particles) implies that it is the movement of the object that causes the slowing. A slowing, and never a speeding up, of a time whose magnitude depends on only relative motion, implies that the effects of motion are real, and must be able to be sensed by the object.

The interpretation of the LT in SR is that relative motion causes the perceived space and time to have matched changes in length and time which then keep the measured speed of light constant. The changes perceived in the other location depend only on relative, not absolute, motion. Observers in either location "see" a time and space for the other location that are altered by matched amounts. An altered time and space are not seen by an observer moving with the object. Time and space are malleable but all observers measure the same speed of light.

This interpretation is faulty; the changes in distance intervals (scale) in the other frame should be the same as the change in their time intervals (dilated intervals giving slower clock rates). The inversion between time and distance allowed the faulty deduction that the changes would match. The apparent dependence only on relative motion arose from mistakenly assuming that v followed by $-v$ gave a return to the stationary frame. Instead it represented movement in opposite directions away from the origin. Time is altered for moving massive clocks and observers but the distance travelled by the same light ray is unaltered. The measured distance will be the same once the measurements are corrected for changes in clock-rate and for apparent changes due to movement during signal transmission. There is no reason to believe that the empty space or distance between objects, not in relative motion, can be increasingly reduced as a function of the speed of the observer, and by the same amount independent of whether the observer is approaching or receding.

Consistency with the revised interpretation of the LT and observations requires that motion relative to a stationary observer, i.e. stationary relative to a background from all other masses, causes a time dilation. It requires, rather than rules out, a background-dependent explanation of the observed kinematics and dynamics of massive objects. Observed behaviour arises from a different pair of postulates than ostensibly used to derive the LT. The underlying speed of light is constant, independent of the velocity of the emitting object (rather than appears, or is measured, to have the same value using inverted time relative to distance intervals) <u>within a constant background</u>. However, the measured value will be altered if the clock used is slowed because of movement relative to the background. Clock-rate will also decrease if an object having mass moves into a region of lower gravitational potential.

Under Full Relativity (FR), there is no requirement that the properties of massive objects be independent of the background. Nor is the speed of light required to be the same for all inertial frames. The effect of differences in gravitational potential is real. The size of the change, for small differences in potential, is dependent only on the difference (assuming the total background potential is constant). Here is the Conclusion from the Okun paper [11]: '*The gravitational red-shift being, both theoretically and experimentally, one of the cornerstones of General Relativity, it is very important that it always be taught in a simple but nevertheless correct way. That way centers on the universal modification of the rate of a clock exposed to a gravitational potential. An alternative explanation in terms of a (presumed) gravitational mass of a light pulse – and its (presumed) potential energy – is incorrect and misleading. We exhibit its fallacy, and schematically discuss red-shift experiments in the framework of the correct approach. We want to stress those experiments in which an atomic clock was flown to, and kept at, high altitude and subsequently compared with its twin that never left the ground. The traveller clock was found to run ahead of its earthbound twin. The blueshift of clocks with height has thus been exhibited as an absolute phenomenon. One sees once over again that the explanation of the gravitational red-shift in terms of a naive "attraction of the photon by the earth" is wrong*'.

There is no reason to propose or assume that changes in time should be matched by changes in the distance between objects. Yet this has been inserted as fact in Einstein's equation of GR. Both FR and GR attribute the changes in time to differences in gravitational potential. However, the Newtonian-based potential of GR is the integral of the gradient of the acceleration, which removes any contribution of a constant uniform background, and hence of total potential. This potential, when measured by an observer at the same potential, has no effect on mass or c, whereas FR has mass, c and inertia dependent on the magnitude (and asymmetry) of the total background potential. The laws of physics are only equivalent after correction for the background.

The Strong Equivalence Principle claims that physics in a frame, freely falling in a gravitational field is equivalent to physics in an inertial frame without gravity. Under FR this is patently false. The reality is that the observer in free-fall is continuously moving into a larger background which reduces mass, but increases inertia and light-speed. The laws of physics are not the same. The effects of gravitational acceleration have not disappeared. The force from the gradient in potential is matched by the inertial resistance to acceleration.

The scale of space (apparent distance between separated stationary objects) should not increase as background density reduces even if the dimensions or wavelength of wave-particle states change. This is because changes in the background medium can alter the speed of light but the medium does not itself carry energy and cannot exert a force on itself. The length of solid rods might change, but not that of empty space. Changes in the dimensions of massive rods cannot be easily tested because the largest objects that can be accelerated to speeds close to the speed of light are heavy ions. These suggest changes occur but the deductions about shape are indirect.

Both GR and FR have clocks running more slowly deeper in a gravitational potential. Under GR this is interpreted as leading to a distant observer at a higher gravitational potential seeing and measuring events as running more slowly at the lower potential. Even the speed of light appears to run more slowly, such that, at the event horizon of a black hole, time stops and no signal from inside can escape. This apparent slowing of light closer to a massive object, becomes real under GR. It is claimed to give rise to a bending of light, with the amount observed half that predicted. The equations of GR then add a matched contraction of space (distance) that doubles the apparent bending. For a spherically symmetric massive source this is the Schwarzschild geometry.

Under FR, the slower ticking of clocks closer to a massive object is an objective reality, an absolute phenomenon [11]. However, the slower ticking arises from clocks having less energy when the speed of light is faster. Thus FR, claims that the speed of light is faster closer to a massive objects and that this leads to bending towards the increase in speed. The bending towards the higher speed is opposite to that claimed by GR and that observed from increasing refractive index slowing speed. This is observed in the bending of light from the rising and setting Sun due to the gradient in density of the atmosphere. This slowing of light in media is due to interactions of the oscillating electromagnetic field of photons with (primarily) the electrons of the material. The photon speed is altered relative to the stationary material's electrons. This same behaviour can be seen in Fizeau's experiment which showed that light will be carried by a flowing liquid. However, photons have no electromagnetic interaction with a vacuum free of charged particles. The oscillations of the photon are relative to its' centroid. A travelling photon in a vacuum (no charged particles) has transverse oscillation speeds of its components that are independent of any flow of the medium, but depend on the magnitude of the medium. The behaviour can be thought of as somewhat like a pair of helices rotating about an axis along the direction of motion. When there is a gradient in the speed of light from an increasing field near a massive object, perpendicular to the axis of motion, the speed around each helix will vary. The effective shortening of the path with speed will cause the light ray (path of the photon) to bend towards the increase in light-speed (by double the amount expected for a single helix).

The idea of block time arose from GR's spacetime in which the order of events depended on the relative location and movement of the observer. It therefore appeared that it must be a four-dimensional block in which the past, present and future already existed.

The philosopher Henri Bergson and Albert Einstein engaged in a heated controversy about time in 1922 [38]. Crease has recently discussed the different perspectives [39]. Bergson considered time as a moving continuity that incorporates and allows surprise, novelty and transformation, while 'scientific time,' on the other hand, 'has no duration'. He argued that it had been turned into an abstract clock time that differs from moment to moment only by measurable distance from another point in spacetime. Einstein curtly dismissed Bergson with the sentence: "There is no such thing as the time of the philosophers". Einstein maintained that there was no absolute space and time and that lengths and time actually dilated. Lorentz and FitzGerald thought there was an absolute space and time in which there were real lengths and time intervals, which contracted and dilated only apparently but not really. Crease considered that these issues were resolved in Einstein's favour.

GR and SR permit a fabric of spacetime in which the space and time perceived by the observer vary but together produce an invariant spacetime interval because the speed of light is a local constant. However, the logic behind SR and GR is flawed. There is no fabric, space is not distorted and there is a time of massive objects (including philosophers!) that has a duration that is related to the relative speed of occurrence of equivalent events in different environments. An underlying reality exists.

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