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Interpretation of Gravity

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Abstract Gravity was discovered accidentally by Newton after he observed an apple falling from a tree. But what actually is gravity and what is its role in nature? However, gravity remains much of a mystery. We experience gravity and are affected by it all the time, and yet we do not know what it really is except for interpreting it as a force or field. This paper takes on the challenging task of examining gravity and suggesting the possible actual role of gravity in nature, from our macro-world to the micro quantum world, and hence the possible unification of gravity with all the other forces of nature, through two modes of reasoning, namely reasoning by *reductio ad absurdum* and by analogy. The paper contains preliminary and explanatory materials which lead to the author's hypotheses in Sections 5 and 6; Section 6 also provides some anecdotal evidence of what gravity is.

Keywords: gravity, forces of nature, space-time, geodesic, dimensions, supersymmetry, gravitons, unification

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1 Overview

Einstein had expended great effort to unify the four forces of nature, namely, gravity, weak nuclear force, strong nuclear force and electromagnetism, but had failed. He had purportedly tried to make use of a set of 16 complex tensor equations, the combinations of ten of which representing gravitation and the remaining six representing electromagnetism, with the concept that a pure gravitational field could exist without an electromagnetic field but a pure electromagnetic field could not exist without an accompanying gravitational field. He was not able to derive the electromagnetic field equations, even for the weak-field approximation, and had no success at all with the unified field theory.

Einstein had hypothesized that gravity is the geodesic of an "imaginary rubber sheet" which occupies space in his paper on general relativity. He had thereby transformed the abstract entity, gravity, into a geometric, more tangible entity that is linked to space-time, which had evidently been an attractive concept to his peers. How should this "rubber sheet" be visualized or interpreted? Is this "rubber sheet" really three-dimensional as has been illustrated by pictures in scientific tomes, or, is it of more dimensions? It is thought that since we are only able to move around in the three large dimensions of length, breadth and height, which are observable, and the time dimension, all other dimensions would have to be very small and invisible to us, curled up in a multidimensional space which could be regarded as representing the invisible micro-world of the quantum particles. This is in line with the concept of the unified field theory which concerns combining General Relativity and quantum theory.

Einstein had believed that David Bohm would be the first to solve the unification problem. However, the latter treated the unified field theory problem lightly, regarding it an "illusion of parts", simply relegating it to the logical constraints of topology and interpreting the universe in a metaphysical way as the "looking-glass" universe. [1] Bohm hypothesized that the unified field theory is based on the illusion of parts (gravity, strong nuclear force, weak nuclear force and electromagnetic force) and is a futile problem; the observer is the observed, the part is the whole, which all seems more metaphysics than physics, this evidently having been the state of physics. He believed that unification could be achieved through the use of the logical relations of topology. [2–4]

2 Gravity, Quantum Particles and General Relativity

There is still a lot of mystery surrounding gravity. Though the effect of gravity is well evident in our macro-world, it seems to have hardly any effect on the quantum particles in the micro-world, the quantum particles apparently whizzing about freely and without the constraint of gravity there, which seems to imply that gravity may not exist in the quantum world.

Unlike the objects in the macro-world, quantum particles in the micro-world are relatively unpredictable in their actions or movements and can only be predicted in a probabilistic fashion if at all. We will never be able to know for certain where a quantum particle will turn up next. Moreover quantum particles are capable of being at two different places at the same time, and, also capable of instantaneous travel or teleportation, which is "spooky" and incomprehensible, and evidently in defiance of gravity – this phenomenon is known as quantum entanglement. We can have a quantum field equation involving infinite dimensions. According to modern quantum mechanics, all possible physical states of a system correspond to space vectors in a Hilbert space. An infinite-dimensional Hilbert space ties up with the theory of the existence of an infinite number of parallel universes connected with each other through worm-holes. [5]

The Schrodinger equation in quantum mechanics, [6,7] which is as follows, can be applied to any physical system in which the mathematical form of the energy is known:-

$$\frac{\partial^2 \Psi}{\partial x^2} + \frac{8\pi^2 m}{h^2} (E - V) \psi = 0 \qquad (1)$$

∂^2 above is the second derivative with respect to x, x is the particle's position, ψ is the Schrodinger wave function, or, the probability amplitude for an electron in the state n to traverse in another direction, m is mass, E is energy and V is potential energy.

The Schrodinger equation describes nature in a deterministic time-symmetrical way. In classical mechanics, when it is pointed out that a quantum system is in a certain "state", it means that the state is a point in phase space. [7] This could be described by a wave function whose evolution over time is expressed by the equation shown below:-

$$ih / 2\pi \, \partial\psi (t) / \partial t = H_{op} \, \psi (t) \qquad (2)$$

The above equation identifies the time derivative of the Schrodinger wave function ψ with the action of the Hamiltonian operator on ψ. It is assumed at the start and is not derived, and can therefore be validated only by experiment. It is the fundamental law of nature in quantum theory. ψ here is the probability amplitude for an electron – it has no physical reality, being only an abstraction. ψ is also, in a way, the intensity wave of the electron. It is a physical probability of the presence of the associated particle when it is squared and the absolute value is obtained.

The square of the normalized amplitude of the individual wave function, that is, ψ^2, represents the probability of the existence of a state. This was another new idea, namely, the probability that a particular quantum state exists. There are no more exact answers in quantum theory, only probabilities. The wave Ψ determines the probability that the electron will be in a particular position, and, unlike the electromagnetic field, it is only an abstraction, that is, it has no physical reality.

Light can be regarded as particles or waves. In quantum mechanics, particles are in fact considered waves. How these particles behave can be predicted, these particles being known as probability waves or Dirac wave particles, which have a wave/particle duality. [8] When the particle is not observed, it stays as a probability wave, but on being observed it becomes a particle.

The following is the formal solution of the Schrodinger equation:-

$$\psi(t) = U(t)\ \psi(0) \qquad (3)$$

where $U(t) = e^{-iHt}$, $U(t)$ is the evolution operator which links the wave function's value at time t to that at the initial time $t = 0$. Both future and past play the same part, since $U(t_1)\,U(t_2) = U(t_1 + t_2)$, whatever the sign of t_1 and t_2. This property results in a dynamical group. [9]

The moot question is: Does gravity affect the particle whose motions are probabilistic and not easy to predict?

Gravity is crucial to the formulation of a unified field theory and can be described by the following formula:-

$$F = G\frac{M_1\ M_2}{R^2} \qquad (4)$$

where F is the gravitational force of attraction, G is the gravitational constant, M_1 and M_2 are the masses of two objects and R^2 is the distance between masses.

Prior to Newton's discovery, nobody had known gravity existed or had thought that there was such a force. In the General Theory of Relativity Einstein interpreted gravity as a curvature of the space-time continuum, a geometrical form. Can gravity be the fifth dimension, in addition to the four dimensions of length, breadth, height and time as per General Relativity?

Gravity is apparently a weak force in nature, making its detection via gravitational waves in our macro-world very difficult. It could possibly be an aspect of the electromagnetic field (which comprises of an electric field and a magnetic field, wherein one mass attracts or repulses another mass and pulls or pushes the latter towards or away from itself), for example, magnetism, or, it could be another field by itself, namely, the gravitational field with its own particles which may be called gravitons.

In 1905, Einstein in his Theory of Special Relativity introduced the gravitational force which was considered responsible for the orbits of planets, as was described by Newtonian gravity wherein gravity was an instantaneous force which propagated through space infinitely fast and was evidently at odds with Einstein's Theory of Special Relativity which posits that nothing can exceed the velocity of light.

Einstein in his General Theory of Relativity published in 1915 introduced a new theory of gravity which was compatible with the special theory. The space-time continuum was introduced in this new theory wherein empty space was likened to a flat rubber sheet which was flexible – a massive object creates an indentation in this empty space, or, "rubber sheet" – this indentation is hence interpreted as an effect of gravity, a curved space-time, a geometry. In fact, in this new theory massive objects determine how space-time curves. The connection between the mass of an object and the space-time curvature can be worked out, this being encapsulated in Einstein's all-important "field equations". Einstein was thus finally able to bring gravity in line with relativity. Below is Einstein's equation for General Relativity:-

$$G_{im} = -\mathbf{K}(T_{im} - 1/2 g_{im} T) \qquad (5)$$

This beautiful equation expresses the curvature of space-time. The left-hand side of the equation represents a set of terms which characterise the geometry of space, while the right-hand side represents a set of terms which describe the distribution of energy and momentum; in other words, the left-hand is the

geometry side, while the right-hand is the matter side. Viewed from left to right is space-time directing mass how to move, while viewed from right to left is mass directing space-time how to curve. In General Relativity, absolute time or space does not exist, and, gravity is a property of space and time and not a force, or, pull between one object and another. All this is a great conceptual leap of Einstein. There is no basis in reality for the coordinate system of Einstein's General Theory of Relativity, which is only a mental construct used to describe the space-time continuum of the General Theory of Relativity. [2,3]

Gravity has always been considered a pulling or attracting force, similar to the force of attraction between two magnets. Gravity and magnetism are possibly different aspects of the same thing. Gravity so far is seen as a force of attraction only whereas magnetic and electric forces are forces of attraction and repulsion. There is possibly a gravitational force of repulsion. Gravity and electromagnetism could be linked resulting in anti-gravitational force and/or torsion in space-time. There may be an anti-gravitational force for every gravitational force, similar to the existence of an anti-particle for every particle. Anti-particles may be ordinary particles traveling backwards in time, implying that anti-particles should have anti-gravity. The electromagnetic and gravitational force-fields could possibly combine to give motive power. All this will affect our approach towards the unification of the four forces of nature.

Quantum particles appear free from the effect of gravity, which seems only to have a negligible effect on them, unlike in the macro-world. On the other hand, gravity could be totally different from what it had been thought to be, thereby possibly rendering unification with the other three forces impossible.

3 Supersymmetry

According to Einstein's theory of gravity, the graviton, the hypothetical quantum of gravity, which is a spin-2 boson, interacts very weakly with other matter, much more so than neutrinos, so weak that no instruments have been able to detect it so far. In the supergravity extension of this theory of gravity, the graviton locates a superpartner, the gravitino, which is a spin-3/2 fermion. These two particles transform one into the other, under local supersymmetric transformations. When quantum calculations were done using supergravity theory, it was found that the infinities which plagued the earlier gravity theory with only the graviton were now being cancelled by equal and opposite infinities caused by the gravitino. This is evidently due to the deeper

consequence of the presence of supersymmetry. This "softening of the infinities" is apparently a step toward a viable theory of quantum gravity, though it is uncertain whether the supergravity theory is totally renormalisable. It hardly matches or reflects the real world with its many particles as simple supergravity theory includes only the graviton and the gravitino. It is evident that some critically important idea is still missing. Due to the absence of this critically important idea, the theories simply do not describe the real world.

How can supergravity theory be made realistic? If this problem can be solved, supergravity theory can be a completely unified field theory. The principle of local supersymmetry is evidently very restrictive, with only eight possible supergravity theories that are each labeled by an integer N = 1, 2 . . . 8. Supergravity theory and the Theory of General Relativity have the same features, namely, conceptual power and mathematical complexity. Possibly, by positing the existence of a single master supersymmetry a unified field theory which accounts for the whole universe can be achieved. [10–12]

4 String Theory

In string theory, gravity is regarded as a vibrating string which vibrates at a certain frequency, while all the particles which are to unite with gravity are each also a string which vibrates at a certain vibrational pattern (a string's vibrational pattern determines its mass and charge). However, for the theory to work, ten dimensions, nine of space and one of time, are needed; this is because if the number of space dimensions is less than nine the number of vibrational patterns would be too small, the smaller the number of space dimensions the smaller would be the number of vibrational patterns, but with nine space dimensions the constraint on the number of vibrational patterns is perfectly satisfied.

String theory has been considered a good candidate for success at unification. [12,13]

5 Methodology for Deriving New Angle on Space-Time and Geometry

There is indeed a striking similarity between the macro-world of planets and the micro-world of quantum particles, namely, that while the planets orbit in ellipses round the sun in the macro-world apparently under the effect of gravitational pull, electrons orbit round the nucleus in the micro-world (perhaps also under the effect of gravity). We would show that there is the

reasonable possibility that gravity is a fluid, with some anecdotal evidence of this described in Section 6, the conclusion.

Gravity is possibly a fluid (similar to fluids such as air, liquid and gas) pathway or guide-rail (a geodesic) which directs or guides the natural movements of the larger objects in the macro-world and miniscule quantum particles in the micro-world, as per the curved space-time "rubber sheet" concept of Einstein – a geometrical, hence more tangible, non-quantum object, which is in accordance with Einstein's equation for General Relativity below, whereby reading from left to right is space-time telling mass how to move, while reading from right to left is mass telling space-time how to curve:-

$$G_{im} = -\mathbf{K}(T_{im} - 1/2 g_{im} T)$$

which could be further generalized by the following field equations of Einstein:-

$$G_{uv} + g_{uv} A = \frac{8\pi G}{C^4} T_{uv} \qquad (6)$$

where:

G_{uv} represents the curvature of space-time

g_{uv} represents the structure of space-time

A (lambda) is the cosmological constant, a term which could describe a repulsive force throughout space – this term, represented by the Greek letter lambda, had been included by Einstein in his general relativity equations which describe how matter and energy bend space-time; [14] A (lambda) might be the result of vacuum energy, the energy in empty space, made of "virtual particles" – pairs of particles and anti-particles which constantly appear and disappear, wherein the particles and anti-particles inter-act and annihilate each other; in turn A (lambda) might cause dark energy which is the force responsible for the acceleration of the expansion of the universe resulting in galaxies flying apart

G is the gravitational constant

T_{uv} represents the energy and momentum of matter and radiation

C is the speed of light

The ideas which follow are an important extension of this concept of Einstein, already explained in Section 2 above, a new angle of the concept – the explanation of gravity as a fluid would be provided.

First, we use the reasoning by *reductio ad absurdum*, that is, reasoning by contradiction. It is probable that Einstein had also entertained the concept of gravity as a fluid but had instead likened empty space to a flat rubber sheet which was flexible, wherein a massive object creates an indentation in this empty space, or, "rubber sheet" – this indentation interpreted as a gravitational effect, a curved space-time, a geometry, as this apparently metaphorical way of explaining gravity by treating it as a "rubber sheet" (which is two-dimensional, while the indentation in it by a massive object would make it three-dimensional) would make his concept of gravity as curved space-time more easily visualized and understood. As the objects in nature are countless and innumerable, this implies that the number of "rubber sheets" (which are basically two-dimensional) or "layers" required to "guide" the movements of the countless and innumerable objects in nature would also be countless and innumerable. The reader could probably imagine these countless and innumerable "rubber sheets" clashing and entangling with each other with possibly catastrophic results for the countless and innumerable objects in nature. The "rubber sheets" represent multiple, countless, innumerable and *discontinuous* "layers" which occupy space. All this depiction of the "rubber sheets" occupying space does not appear to give a true, accurate or sensible picture of nature, that is, this depiction of space-time appears a point of absurdity or ludicrousness which implies that it could not be the truth or fact. On the other hand (that is, by contradiction), if all the countless and innumerable "rubber sheets" were replaced by a fluid, which has *continuity*, there would be only *one continuous "layer"* in nature to "guide" the movements of the countless and innumerable objects in nature, which makes more practical sense; it would evidently be easy to visualize the objects of nature moving smoothly and without difficulty through a fluid, such as water or air, instead of through "rubber sheets". It is thus likely that Einstein had adopted the concept of the "rubber sheets" only as a simplification and

metaphor for describing gravity, as is stated above. [15] Hence, by *reductio ad adsurdum* or contradiction it is shown that the concept of gravity being a fluid is a credible or reasonable one. We progress from here to reasoning by analogy below and to describing the anecdotal evidence that gravity is a fluid in Section 6, the conclusion, which further shows the credibility of gravity as a fluid.

Gravity could be regarded as the medium or carrier-wave all massive objects in the macro-world and all quantum particles in the micro-world travel in, similar to the case of sound or vibrations travelling through air or liquid which become the media for their transmission, or TV or radio signals being carried by carrier waves over very long distances. Gravity may even be regarded as the analog of the theoretical luminiferous ether, the medium by which light has been thought to travel.

As a fluid, flexible medium, like air, liquid or gas, gravity thus possibly links the macro-world of planets and the micro-world of quantum particles (through what may be described as a fluid space-time continuum). For example (as an analogy), liquid (and even air or gas) would fill up any empty space it encounters, from the seas and rivers, etc. (macro-world), to the tiny capillaries (micro-world) in soils, rocks, etc., even moving or washing away some of the soils, rocks, and any other objects in its way. That is, gravity could be reduced to this fluid geometrical form, similar to liquid, air and gas.

What we see as the effects of gravity could be analogous to how objects of different densities behave, for example, when immersed in liquid, denser objects would settle to the bottom of the liquid (in fact very quickly so if the object is very dense) while the less dense objects would be suspended nearer or at the top (like the denser objects which sink to the sea-bottom while the less dense objects float nearer or at the top of the ocean), also, look at the case of objects falling or rising in the air, for example, solid rocks falling down through the air and helium-filled balloons rising in the air. Consider further the case of the falling rocks as an interesting example: The strength of the gravitational field (g) affecting the falling rock is considered equal to the acceleration (a) of the falling rock under its influence, wherein the value of g is as follows:-

$$g = 9.80665 \text{ m/s}^2 \ (32.1740 \text{ ft/s}^2)$$

If the falling rock is thrown down with a force, according to Newton's second law, the rate of change of momentum p of the falling rock equals the total force F acting on it, as is described by the following equation:-

$$F = \partial p/\partial t \qquad (7)$$

If, as is normally the case, the mass of the falling rock is constant, $F = \partial(mv)/\partial t$ reduces to $F = m\partial v/\partial t$ or $F = ma$, where a is the acceleration of the falling rock, the force (F) and acceleration (a) being vectors.

However, as is explained in Section 2 above, in General Relativity, space and time are not absolute, and, gravity is a property of space and time and *not a force, or, pull between one object and another*, which is opposed to the example of the falling rock immediately above. As for the case of outer space and other planets such as the moon, the possibly denser fluid gravity there may allow astronauts to float in it, which could be interpreted as the "lesser effect of gravity". The suspension, floating and orbiting of the planets in outer space (which is comparable to birds/objects suspended/floating freely in the air and fishes/objects suspended/floating in water in the sea), apparently under the influence of gravity, is possibly a manifestation of the above-described phenomenon.

Just as waves could be detected in liquids and air, it is thought that gravitational waves could be detected. But since gravity is considered a very weak force the detection of gravitational waves would be very difficult.

The other important point to consider is on the make or composition of the above-mentioned gravitational fluid which possibly exists. What would this possibly existent gravitational fluid be composed of? Could it be made of air, liquid or gas, or a combination of some or all of the three? Could it be composed of some element or elements, or, particle or particles, which may be waiting to be discovered? The theoretical graviton may be a potential candidate but it has been regarded as a quantum particle whereas this gravitational fluid aka curved space-time is non-quantum. [16]

6 Conclusion

It could be concluded that gravity is either a geometrical, non-quantum entity (as is explained in Section 5 above wherein gravity is shown to be a fluid) or a quantum entity (the quantum of gravity having been labeled as graviton).

Though there are a number of interpretations of gravity, only one of them could possibly be the correct interpretation, which has also to be successfully confirmed by empirical evidence, and that is apparently a great problem,

gravity being apparently such a weak force and hence very difficult to detect; gravitational waves would be very difficult to detect even with advanced scientific equipment which may not be sensitive enough to detect them, and, if gravity were indeed a quantum force like electrons, for example, the detection of its quantum particles, namely, gravitons, would also be very difficult. However, the unification of gravity with all the other forces of nature could possibly be achieved by one of the above-mentioned ways.

The search for gravitational waves is still ongoing. The existence of gravitational waves so far is inconclusive – there is only indirect evidence of their existence. In frame dragging, which is a gravitational effect, objects occupying the space close to a rotating object are swept around with it; rotating objects drag space around with them like the effect of a spoon in motion in treacle (syrup), *which appears to corroborate the theory that gravity is a fluid (analogous or similar to treacle (syrup), which is also a fluid), which is explained in Section 5 above*. Scientists studying the data from two Earth-orbiting satellites in 2004 apparently discovered evidence of frame dragging – they claimed to have found the minute frame dragging effect of our planet. Useful energy could possibly be extracted from the rotation of our planet, which could be a power source for an advanced civilization.

Gravity has so far been regarded as an attracting or pulling force. But couldn't gravity be possibly a pushing force instead, which is the equivalent of the attracting or pulling force? For example, a door could be closed by someone *pushing* it out from the inside, or, someone *pulling* it out from the outside (or, vice versa, someone *pulling* it in from the inside, or, someone *pushing* it in from the outside), with the same "closed door" result. This different way of looking at gravity deserves some consideration.

Unification should result in an equation which would connect the visible macro-world with the invisible micro-world of the quantum particles, which would link gravity with the weak nuclear force, strong nuclear force and electromagnetism, an equation that should contain all the information about the universe. This unified theory may also be called the theory of everything (TOE).

Finally, we conclude that there is the reasonable, credible possibility that gravity is a fluid.

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