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Speculations on The Nature of Time and Space

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ABSTRACT

One examines the conception of 'now', regarding time, in distinguishing the past and future, and regarding the ZPF vacuum space, as a possible hyperspace dimension and the nature of gravity of the vacuum (dark energy) being repulsive. One examines the nature of space expansion of the universe, as the continuous creation of space and time since the Big Bang, how it's taken for granted that there's no explanation of the why and how of the mechanism of expanding space, and how the creation of energy (virtual particles) in empty space by Heisenbergs uncertainty principle may be a clue to the nature of expending space, or the creation of space from nothing. After this, one applies Mach's principle to the repulsive gravity of the vacuum (dark energy) and one speculates that the expansion of the universe being faster than light, might create causal violations, followed by the nature of the speed of time.

Keywords: time; space; Heisenberg's uncertainty principle.

INTRODUCTION

One examines the conceptions of 'now', which allows the distinction of the past and future, and how an object (mass) is extended temporally through time, that 'now' might be an illusion, that we are only aware of 'now' and not the past or future. Being aware of all the future and past, one would lose the distinction of the 'now' in experience.

That the ZPF vacuum of space might be a hyperspace dimension, regarding tunneling of a particle through a potential barrier, as through a hyperspace dimension, because particles tunneling do so faster than light, and that gravity might operate through such a hyperspace dimension.

There are paradoxes in the notion of the expansion of space, in that more space is created in the expansion of the universe. That Heisenberg's uncertainty principle in the appearance of energy out of empty space and disappearing again into nothing of empty space (virtual particles) might be a clue to the creation of more space.

One further considers Mach's principle applied to the repulsive gravity of the vacuum, i.e., dark energy, that it must obey an inverse square law, that the further the distance of galaxies, the stronger the repulsive gravity of the vacuum ZPF. From this, one considers that if the recessional velocity of galaxies on the light horizon is superluminal, does the expansion of the universe cause causal violations, because anything propagating faster than light would propagate into the past?

One finishes by regarding the paradox that if the speed of time is at the speed of light, then time would not exist. That the 'now', we experience, that time would not exist, and would be a timeless moment, which is a contradicted by post selection experiments, where it's proved that particles are influenced in the past by the future, suggesting that the past does exist objectively, and that it's a mistake to assume the speed of light to be the speed of time. One suggests the speed of time might be faster than light.

ON TIME, HYPERSPACE AND GRAVITY

Energy and mass are temporal phenomena. The past and the future are fixed; post-selection experiments prove this, where a particle in the future can influence a particle in the past. Then objects (mass) are extended temporally through time, as if stretched out on the continuum. Such a view seems to be argued in special terms, not temporal terms, and might not be the correct way of thinking about it. One can often make the mistake of thinking of time in terms of space and not time.

In the relative concept and experience of 'now', it might be an illusion that makes us not aware of the future and the past. But our perception of 'now' makes us able to distinguish the past from the future, but at the same time not aware of the past or future. But is this objective? For physics to deny the existence of 'now', in time, is to deny the present and only have the past and future. It has to include the 'now'.

Wherever one is in time, in the past or future, has its 'now' from an observer's reference frame in that past or future, all other times from such reference frames of 'now' are then in the past or future to us in the present, to our 'now', here. One could ask if the 'now', merely psychological? Depending on an observer's frame of reference, of where one is in time, or is 'now', objective. If it's objective, then what are the past and future compared to this objective 'now', that moves along the space-time continuum with the flow of time, is denying any objective reality to an observer's frame of reference in perceiving the 'now' in the past or future? If we could perceive the whole of time, the whole of the past, and the future in its entirety, then we might not be able to distinguish a 'now'. Our perception is not made that way; only God can know the whole of time.

What is matter (mass) and energy from the point of view as existing in the whole of time, along the continuum world line. Taking time as a whole, is thermodynamics then an illusion? Is $t = 0$ a point in now and illusion for all the supposed 'nows', in all the pasts and futures, because taken as a whole, there are no 'nows' and what are perceived as 'nows', are just slices in the continuum of the world line of all these 'nows'. If one views the whole, then this is the Einstein block model of the universe, and taken as a whole, the distinction between the past, present, and future becomes an illusion. For in the block model of the universe, having the whole of the future and past laid out, where can one say is the future or the past or the present, even the concept of 'now disappears, for where can one say is 'now', is it the 'now' in the past or the future, which one would be more significant than the other, in this situation, 'now' loses its meaning. Also, if time is infinite, taken as a whole of this infinite time, the past and future lose their meaning; nowhere does one go before the other, it is only in a slice of an infinite world line, in a point on that world line that there is a 'now' and a past and future. But as a whole, it's illusory.

Energy and mass, time and energy must be fundamentally connected with each other. Energy is known as the capacity to do work. But no one knows what energy is. In tunneling experiments, the particle tunneling occupies the whole of that tunneling space, is in a superposition state. Here, energy occupies the whole of space simultaneously; the particle is invisible, non-local, is a virtual particle, and faster than light. Seeing this as the case, the vacuum ZPF has to have these properties, because the vacuum ZPF particles are virtual particles.

So the particle tunneling may exist in another dimension, the ZPF dimension of the vacuum. Is this dimension really hyperspace, is the particle tunneling in hyperspace, going faster than light. What role does time play here, how is time associated with hyperspace or the vacuum ZPF, that Puthoff argued in a paper [1], where he says on pages 690 - 691: How the ZPF may be shown to give rise to the inertial mass of a particle. The ZPF could thus serve as the Machian cosmic reference frame. This may in turn be related to the cosmic distribution of matter in the context of the model of dynamically balanced absorption and reemission of ZPF radiation by mass distributed over cosmological space.

In tunneling the energy, the particle, the mass is everywhere in a superposition space through a potential barrier, shall the same be said of the vacuum ZPF? What role does time play here? If in tunneling the particle is going faster than light, then is it propagating into the past, does effect arise before cause? This is what Gunter Nimitz talked of in a paper, 'Tunneling violates special Relativity', especially references 14 and 15. This is really effect arising before cause, the same effect that Bajlo [2][3] pointed out in regard to advanced waves and are really outgoing waves, regarding two flows of time, one into the past, and one into the future, where because we are not travelling faster than light or into the past, we only observe effect before cause (of the advanced waves). But the particles' tunnelling is really from the above logic is travelling into the past, but because of our thermodynamic arrow, we view it arriving from the past to the present, just as advanced waves do.

What role does time play in tunneling, it's a state of time flow into the past, of a particle going backward in time, faster than light, from the past to the future. What role does time play in the vacuum ZPF, being a possible Machian cosmic reference frame? If ZPF is a hyperspace dimension and energy state, time here is related to Heisenberg's uncertainty principle for energy and time:

$$\Delta m \times \Delta t = \frac{h}{2\pi c^2} \qquad (1)$$

$$\Delta t = \frac{1}{\Delta m} = \frac{h}{2\pi c^2} \qquad (2)$$

This might be a virtual energy state of a hyperspace dimension, where there is an inherent uncertainty over time Δt. This is a time in the quantum area, where particles are in superposition, can have the probability of being in the future or past, and influence the future or past.

Gravity is also a temporal phenomenon in Mach's principle; gravity might be faster than light, might propagate into the past. In gravitational fields, time is slowed; is gravity operating through hyperspace? Regarding Mach's principle, is gravity then, non-local, virtual, invisible, and faster than light. The same property one finds in particles tunneling through a potential barrier. For example, if gravity travelled at the speed of light, the whole galaxy would not be gravitationally held together, gravity would not have had time to reach the end of the galaxy, there would be a gravitational delay, and this has not happened. So gravity must be superluminal and perhaps propagates into the past. This is also considered in a paper [7] by Waterzhu, 'The speed of Gravity: and an observation on galaxy motions'. Waterzhu says in his abstract: The radius of a spiral galaxy is usually 5×10^4 light years. The stars, planets, and other masses are orbiting around the centre of the galaxy. If the speed of gravity were equal to the speed of light, the star at a distance of 5×10^4 light years from the centre, only could orbit at the time of 5×10^4 years ago. It should result in a galaxy that is not in the form of a disc. Usually, a galaxy is older than 1×10^{10} years. In this time, a galaxy should become a strip longer than 5×10^6 light years. It is contradicted by observation.

So here we see that it's more probable that the speed of gravity may be faster than the speed of light. If this is the case, is a tunneling state, a gravitational field of the vacuum? If the vacuum ZPF has the property of a gravitational field, i.e., repulsive gravity, or dark energy, a repulsive force of the vacuum, which is responsible for the expansion of space. Such a repulsive gravity field would be the Machian cosmic reference frame of hyperspace dimension. In the scale of the tunneling state, such repulsive gravity of dark energy (of ZPF of vacuum) would hardly be detectable, but on the size of the universe, it would be stronger.

The scientific idea of a gravitating void was put forward by Albert Einstein in 1917. In Einstein's model of the universe, to balance the forces of gravity and to make the universe stationary, he introduced forces of repulsion independent of the specific properties of matter and introduced the cosmological constant Λ. And this is known today as dark energy or ZPF. Dark energy might be a hyperspace dimension or part of it?

ON THE NATURE OF SPACE

There is a paper by a Russian scientist [4] Yu. Baryshev, 'Expanding space: the root of conceptual problems of cosmological physics'. He says in his abstract: The space expansion physics contains paradoxes which were clearly demonstrated by Edward Harrison (1981, 1995, 2000), who emphasized that the cooling of homogeneous hot gas (including photon gas of CBR) in the standard cosmological model is based on the violation of energy conservation by the expanding space. In the modern version of SCM, the term 'space expansion' actually means continuous creation of a vacuum, something that leads to conceptual problems. Recent discussions by Francis, Barnes, James, and Lewis (2007) on the physical sense of the increasing distance to a receding galaxy without motion of the galaxy are just a particular consequence of the arising paradoxes. Here we present an analysis of the following conceptual problems of the SCM: the violation of energy conservation for local comoving volumes, the exact Newtonian form of the Friedmann equation, the absence of an upper limit on the receding velocity of galaxies which can be greater than the speed of light, and the peresence of the linear Hubble law deeply inside inhomogeneous galaxy distribution. The common cause of these paradoxes is the geometrical description of gravity, where there is no well-defined concept of the energy-momentum tensor for the gravitational field, no energy quanta - gravitons, and no energy-momentum conservation for matter plus gravity because gravity is not a material field.

Does it make sense to talk of an expanding universe, the notion of the expansion of space itself, of the creation of space, of the ZPF vacuum. If the universe is infinite, can it still expand? Yes, it can through the creation of more space, of the vacuum, creating space from nothing. Yet I feel there is something paradoxical in the notion of an infinite universe expanding.

The Big Bang is the creation of space-time. Through the expansion of space of the universe, there is the continual creation of space-time, of 4 dimensions of space-time; it has to be a constant ongoing process of creating 4 or more dimensions. Perhaps the energy of the vacuum $\varepsilon = 10^{49} gram/cm^3$ goes into the creation (dark energy, gravitating void, that energy of the vacuum that self-cancels), regarded as repulsive gravity? There is the Heisenberg uncertainty principle:

$$\Delta t \times \Delta m = \frac{h}{2\pi c^2} \qquad (1)$$

$$and\ for\ energy \qquad \Delta E = \frac{1}{\Delta t} = \frac{h}{2\pi} \qquad (3)$$

This might be a clue; it's the creation of energy out of nothing, due to an inherent uncertainty of energy and mass in empty space. A clue perhaps to the mechanism of the creation of space out of nothing. If energy and mass can appear out of nothing, can space? The creation of 4 dimensions of space-time? In cosmology, everyone takes for granted the expansion of space in the universe, but does not question what this means? How can you have empty space creation/expansion in, not empty space?

In a university textbook on Astronomy, 'Universe', edited by Roger A. Freedman and William J. Kaufmann III, they say on page 635: It is important to realize that the expansion of the universe occurs primarily in the space that separates clusters of galaxies; galaxies themselves do not expand. Einstein and others have established that an object that is held together by its own gravity, such as a galaxy, is always contained within a patch by its own gravity. Such galaxies gravitational field produces this non-expansion region, which is indistinguishable from the rigid space described by Newton. Only the distance between widely separated galaxies increases with time.

I am not totally convinced by this argument; it sounds artificial, of course, it might be right? Yu. Baryshev says in his paper [4], the cause of these paradoxes is the geometrical description of gravity, where there is no well-defined concept of the energy-momentum tensor for the gravitational field (for the descriptions of expanding space). According to GR, gravity is described by a metric tensor g^{ik} Of a Riemannian space. The 'field' equations in GR may be written in the form:

$$R^{ik} - \frac{1}{2} g^{ik} R = \frac{8\pi G}{c^4} \left(T_m^{ik} + T_{de}^{ik}\right) \qquad (4)$$

Where R^{ik} is the Ricci tensor, R is the scalar curvature, T_m^{ik} is the energy momentum tensor (EMT) for usual matter, and T_{de}^{ik} is the EMT of the dark energy component, which includes the cosmological constant and cosmological vacuum. The most important feature of Einstein's equ (4) is that the right part does not include the energy-momentum of the gravitational field itself.

And this is where I think the problem lies: there is no well-defined concept of the energy-momentum tensor for the gravitational field. That gravity in GR is not a kind of matter, so the total EMT does not contain the EMT of the gravity field.

Yu. Baryshev says further, each comoving finite box in an expanding universe continuously increases its volume, so it gets more and more cubic centimeters. Physical expansion of the universe means the creation of space together with the physical vacuum. Creation of space may be visualized by a 2-d analogy with an expanding sphere in 3-d space, where the surface of the sphere increases with time, and for 2-d beings, their universe grows with time (gets more square centimeters). The real universe is not homogeneous; it contains atoms, planets, stars, and galaxies. Bondi (1947) considered spherical inhomogeneities in the framework of GR and showed that inside them, the space expands slowly. In fact, bounded physical objects like particles, atoms, stars, and galaxies do not expand. So inside these objects, there is no space creation. This is why the creation of space is a new cosmological phenomenon, which cannot be tested in a laboratory, because the Earth, the Solar System, and the Galaxy do not expand. He also says you get violations of the energy conservation in expanding space.

Most textbooks on Astronomy don't explain the why and how of the mechanism of expanding space? Yu. Baryshev says further in his paper: Contrary to the lab case, in expanding space, the cosmological pressure does not produce work. It was noted by Harrison (1981; 1995) that in a homogeneous expanding unbounded expanding FLEW model, one may imagine the whole universe partitioned into macroscopic cells, each of comoving volume V, and all having contents in identical states. The $-pdV$ energy lost from any one cell cannot reappear in neighboring cells because all cells experience identical losses. So the usual idea of an expanding cell performing work on its surroundings cannot be applied to the cosmological case.

He goes on:
In cosmology eq.(19) $dE + p\, dV = 0$ (19)
Where $dE = d(\varepsilon V) = d(\rho c^2 V)$

Gives us a possibility to calculate how much the energy increases or decreases inside a finite comoving volume, but it does not tell us where the energy comes from or where it goes.

But the energy of space, of the vacuum, is $10^{94}\, grams/cm^3$ and an enormous amount of energy that self-councils (where it comes from or where it goes is from the vacuum, from Heisenberg's uncertainty principle for energy and time, perhaps driving the creation of space?) is a violation of conservation of energy, appears out of nothing, and disappears. But it can also manifest as real energy, as Yu. Baryshev says, 'It does not tell us where the energy comes from, or where it goes'. But then, if one got the creation of new space, vacuum energy would appear and disappear from empty space.

In a Book: 'The evolution of the universe', [5] by I/D/Novikov, on page 60, he says: The Soviet physicist Ya.B. Zel'dovich put forward arguments that demonstrate in simple terms how a non-vanishing energy density of the vacuum could emerge. Virtual particles with a rest mass m (for simplicity, we consider only one kind of particle) are being created and annihilated in the vacuum. The average density of proper mass (or proper energy - the quantity differing from the mass density according to Einstein's formula $E = mc^2$ by the factor c^2 only) of virtual particles does not enter the final expressions and may be set equal to zero, as has been mentioned already. Quantum theory associates a characteristic length $l = \hbar/mc$ with any particle of mass m, where $\hbar$ is Planck's constant divided by 2π. The average separation of a newly born pair of virtual particles is about the characteristic length l. The energy of the gravitational interaction of such a pair can be estimated from the conventional formula:

$$E = \frac{Gm^2}{l}$$

It is this energy that can give rise to the non-vanishing energy density of the vacuum, or, correspondingly, to a non-vanishing mass density of the vacuum $\rho_{vac} = \varepsilon_{vac}/c^2$. To estimate the density of energy ε, we divide E by the volume l^3 occupied by one virtual particle:

$$\varepsilon_{vac} = (Gm^2/l)l^3 = Gm^6c^4/\hbar^4$$

The last term in the above equation is obtained by the substitution of $\frac{\hbar}{mc}$ for l. This is not all, however. The theory also requires that the 'vacuum fluid' exert some pressure, but, in contrast to pressure in the usual sense, this vacuum pressure must be negative. It would be even better, perhaps, to speak of the strain rather than pressure. The absolute magnitude of the vacuum pressure must be equal to that of the energy density, i.e., $p = -\varepsilon$ making use of the Einstein relationship, we can rewrite it as $p = -\rho c^2$, or $\frac{p}{c^2} - \rho$. This property is very important and, as we shall see in a moment, may very well be the primary cause of the gravitational repulsion of the vacuum.

MACH'S PRINCIPLE APPLIED TO THE REPULSIVE GRAVITY OF THE VACUUM ZPF

As one is considering the nature of space, or the vacuum, just as Mach's principle applies to normal distant mass in the universe, causing inertia in bodies, so it should also apply to the gravity of the vacuum. The gravity of the vacuum is repulsive (as stated above by Novikov), also known as dark energy, to distant mass/expanding space; the further the distance, the stronger the repulsion of distant bodies. The rate of the creation (expansion) of space can be faster than light for the most distant galaxies, on or just beyond the light horizon of the universe. Would the energy of the vacuum propagate into the past, as it would be expanding faster than light for the most distant galaxies.

Would space expansion influence distant bodies, being just the creation of space. But the repulsive gravity of the vacuum might push all distant matter away from each other, the larger the distance. Mach's principle states that a body rotating feels the force of inertia of the gravity of all distant matter in the universe. But when at rest, not rotating is analogous to free fall or a geodesic. In this sense, distant galaxies rotate, must also feel the negative inertia of the repulsive gravity of the vacuum pushing each galaxy away from the others, and the stronger the repulsive force. Of course, this is pure speculation, and may explain the rotation curves of galaxies as not due to dark matter, but dark energy? The distinction has to be made between the expansion of space (creation of more space) to the repulsive gravity of the vacuum. The measure of inertia in rotating galaxies will depend on the existence of the background, of the whole of the vacuum repulsive gravity of the universe, in proportion to its distance, and is equal to an inverse square law; the repulsive gravity increases as the square of the distance:

$$F = \frac{-G}{4\pi d^2} = a_{vac} \qquad (6)$$

Where $a_{vac} = \frac{4}{3}\pi G 2\rho_{vac} R$.

This shows that the gravity of the vacuum is not attractive, but repulsive. Such a repulsion stems from the fact that the vacuum pressure is negative. Equation (6) is an inverse square law relating the force F and the strength of repulsive gravity increases as the square of the distance. As the acceleration of space of distant galaxies can be faster than light, one can write equation (6) as:

$$F = \frac{-G}{4\pi d^2} = a_{vac} > c$$

Where here the acceleration a_{vac} is faster than light. Also, that gravity increases as the square of the distance, that $-G$ behaves as the reciprocal of a scalar field ϕ. This ϕ has to be related to the vacuum:

$$\phi^{-1} \sim -G = \frac{p}{c^2} - \rho \qquad (7)$$

This may well be the primary cause of the gravitational repulsion of the vacuum.

Here we have Mach's principle in quantitative form:

$$G = \frac{c^2}{\sum_i \frac{m_i}{r_i}} \qquad (8)$$

And here is a similar equation of Mach's principle for the repulsive gravity of the vacuum:

$$\phi^{-1} \sim -G \sum_i \frac{m_i}{r_i} = \frac{p}{c^2} - \rho \qquad (9)$$

This means that vacuum antigravity continuously increases in time due to the continuous creation of matter in the steady state cosmological model is just a particular case of the new physics of expanding space. If the vacuum ZPF serves as a Machen cosmic reference frame, that reference frame is moving (expanding), creating new space of the universe and is therefore a moving reference frame of the whole universe. It follows an inverse square law that the further the distance, the stronger the repulsive gravity of the vacuum. Galaxies at and beyond the light horizon would have motion faster than light. The cosmic Machen reference frame follows an inverse square law as in equation (6). So space or the vacuum, it's a moving reference frame that is a dimension of space-time, that is being continually created. Therefore, nothing in the universe is static. Locally, things may seem to be at rest, but globally, everything in the universe, including space, is in motion.

In treating the vacuum as a reference frame, in special relativity, space is regarded as static in relation to any reference frame. But in reality, the space is expanding in proportion to an inverse square law. How does this stand with special relativity, where galaxies on the light horizon have a recessional velocity faster than light, which is a violation of special relativity. The expansion of space in our galaxy is hardly detectable, can be treated as a static reference frame in special relativity, but not for cosmic distances, where the speed of *c* is violated.

In a paper [6] by Marc-Thierry Jaekel, Astrid Lambreche, and Serge Reynaud, 'Relativity of motion in vacuum', they say in their paper: The principle of relativity applies in particular to motion in empty space; it is related to the symmetries of this space. The principle of relativity of motion is directly related to symmetries of the quantum vacuum. And on cosmic scales, the symmetries of quantum vacuum are repulsive for the expansion of space and recessional velocities of galaxies being faster than light, and beyond the light horizon.

After my comment above, they say further in their paper: Movement in space cannot be defined otherwise than moment in vacuum. Motion which is uniform velocity is indistinguishable from rest. The invariance of vacuum under Lorentz transformations is an essential condition for the principle of relativity of motion, and it establishes a precise relation between this principle and a symmetry of vacuum. Space is not empty, since vacuum fluctuations are always present. These fluctuations effectively represent a reference for the definition of motion, because they give rise to real dissipative effects in the general case of arbitrary motion.

DOES THE SUPERLUMINAL EXPANSION OF THE UNIVERSE CAUSE CAUSAL VIOLATIONS

Let me first say that this is totally speculative. It has been considered by some that the expansion of the universe is expanding faster than the speed of light, that it is space itself that is, in fact, expanding at this rate. There is no restriction on the expansion of actual space at speeds faster than the speed of light, but there is a restriction on objects.

That the most distant parts of the universe beyond the light horizon could be moving away from us at many millions of times the speed of light. Regarding actual space, according to quantum physics, it is full of energy, dark energy, or virtual energy that pervades empty space. This energy is causing the expansion of the universe faster than the speed of light. But one thing in all of this that has not been said, as far as I know, is that this dark energy should then be propagating into its own past. Because it's also considered that anything moving faster than light travels backward in time. The question then is, does the superluminal expansion of space cause relativistic effects with dark energy, or produce causal violations? It's this dark energy that is causing the expansion of the universe.

If the universe expands faster than light, and this dark energy does propagate backwards in time, then the whole universe is sort of folding back upon itself. And where this dark energy is causing this superluminal expansion, it would exist in a different time/space dimension.

As Richard Feynman has said, 'Every particle in nature has an amplitude to move backwards in time, and therefore has an antiparticle'. The spontaneous appearance of this vacuum energy in empty space is always made of particles and anti-particles, is that not part of this vacuum energy that appears; really, the same dark energy that is propagated into its own past from the expansion of space, that this vacuum energy that appears is, in fact, from the future?

Although light and objects within spacetime cannot travel faster than the speed of light, this limitation does not restrict the metric (space) itself from being faster than the speed of light. While special relativity prohibits objects from moving faster than light with respect to a local reference frame, where spacetime can be treated as flat and unchanging, it does not apply to situations where spacetime curvature or evolution in time becomes important. These situations are described by general relativity, which allows the separation between two distant objects to increase faster than the speed of light, although the definition of ''separation'', is different from that used in an inertial frame. This can be seen when observing distant galaxies more than the Hubble radius away from us (14.7 billion light years). These galaxies have a recessional speed that is faster than the speed of light.

Comoving coordinates. While general relativity allows one to formulate the laws of physics using arbitrary coordinates, some coordinate choices are natural choices with which it is easier to work. Comoving coordinates are an example of such a natural coordinate choice. They assign constant spatial coordinate values to observers who perceive the universe as isotropic. Such observers are called ''comoving'' observers because they move along with the Hubble flow. A comoving observer is the only observer who will perceive the universe, including the cosmic microwave background radiation, to be isotropic. Non-comoving observers will see regions of the sky systematically blue-shifted or red-shifted. Thus isotropy, particularly isotropy of the comic microwave background radiation, defines a special local frame of reference called the comoving frame, is called the peculiar velocity of the observer. Most large lumps of matter, such as galaxies, are nearly comoving, i.e.; their peculiar velocities are low.

The comoving time coordinate is the elapsed time since the Big Bang according to a clock of a comoving observer and is a measure of cosmological time. The comoving spatial coordinates tell us where an event occurs while cosmological time tells us when an event occurs. Together they form a complete coordinate system, giving us both the location and time of an event. Space in comoving coordinates is (on average) static, as most bodies are comoving, and comoving bodies have static, unchanging comoving coordinates. The expanding universe has an increasing scale factor which explains how constant comoving coordinates are reconciled with distances that increase with time.

Comoving distance is the distance between two points measured along a path defined at the present cosmological time. For objects moving with the Hubble flow, it is deemed to remain constant in time. Uses of the comoving distance. Cosmological time is identical to locally measured time for an observer at a fixed comoving spatial position, that is, in the local comoving frame. Comoving distance is also equal to the locally measured distance in the comoving frame for nearby objects. To measure the comoving distance between two distant objects, one imagines that one has many comoving observers in a straight line between the two objects, so that all of the observers are close to each other and form a chain between the two distant objects. All of these observers must have the same cosmological time. Each observer measures his distance to the nearest observer in the chain, and the length of the chain, the sum of distances between nearby observers, is the total comoving distance. It is important to the definition of comoving distance that all observers have the same cosmological age. For instance, if one measured the distance along a straight line or geodesic between two points, one would not be correctly measuring comoving distance. Comoving distance is not quite the same concept of distance as the concept of distance in special relativity. This can be seen by considering the hypothetical case of a nearly empty universe, where both sorts of distance can be measured. In this thought experiment, the value of comoving distance is not equal to the value of the distance as defined by special relativity.

If one divides a comoving distance by the present cosmological time (the age of the universe) and calls this a ''velocity'', then the resulting ''velocities'' of ''galaxies'', near the particle horizon or further than the horizon, can be above the speed of light. This apparent superluminal expansion is not in conflict with special or general relativity, and is a consequence of the particular definitions used in cosmology.

Note that the cosmological definitions used to define the velocities of distant objects are coordinate-dependent - there is no general coordinate-independent definition of velocity between distant objects in general relativity. The issue of how to best describe and popularize the apparent superluminal expansion of the universe has caused a minor amount of controversy.

I like to comment about the above; special relativity applies to objects moving through spacetime, not to the expansion of spacetime itself, which would be a moving frame of reference, not static, but superluminal. Space can expand faster than light. But the contradiction here with relativity is that distant galaxies are carried along the superluminal expansion of the universe, which is still a violation of special relativity.

The repulsive force in empty space causes distant objects to move apart with a relative velocity proportional to the distance separating them. This means that objects separated by greater than a certain distance will actually be moving apart faster than the speed of light.

$$F = \frac{-G}{4\pi d^2} = a_{vac} > c \qquad (10)$$

This is also the inverse square law of dark energy, of the repulsive gravity of the vacuum, and the acceleration of the vacuum space a_{vac} being faster than light.

Regarding the theory of inflation, that early on, after the Big Bang, the universe increased in size suddenly, and that this period of inflation took place faster than the speed of light. But if so, this energy will be propagating back in time to its point of origin. Anything going faster than light goes backward in time. Does this present a paradox? It presents a view that the universe would have been folding back upon itself to an earlier time, just after the Big Bang. Certainly, there would be a buildup of energy in the past from this period of inflation, or energy would appear from the future of the universe back to its point of origin at the Big Bang. The universe would be sort of folding itself back upon itself, creating two flows of time, one forward in time, the other backward in time.

THE SPEED OF TIME

Can one write an equation for the present ''now''? There is an equation:

$$ds^2 = c^2dt^2 - dx^2 - dy^2 - dz^2 \qquad (11)$$

The paradox here is that the speed of time is at the speed of light:

$$ds^2 = c^2dt^2 \qquad (12)$$

A moment that time exists at the speed of light is a paradox, because at the speed of light, for a photon, time does not exist. In the expression of equ (11), the last 3 terms express that everything is moving around you, and you are at rest. So the last 3 terms disappear and one is left with equ (12). ds is spacetime. So you still experience the passage of time, you're moving through spacetime just along the axis dt^2. But how fast are you moving through spacetime It's really c. That is $ds^2 = c^2dt^2$. This is the temporal speed of time.

1- Travelling through space at c, at the speed of light, time disappears, as time does not exist for a photon.
2- Not travelling through space, at rest in space, time travels temporally at c, at the speed of light for us through time.

If time is at the speed of light, the present moment, ''now'', time would not exist, which is paradoxical, either this is why time would not exist in the past, present, and future. This has to be wrong because post-selection experiments show that particles can be influenced in the past by the future. There is something wrong with regarding the ''now'', as a state of time not existing? The paradox is that at the speed of light, time does not exist, is frozen, is at a standstill. So how can its speed be at the speed of light? This implies that the ''now'' of our experience, that time does not exist for us in the ''now'' - which might be wrong? Why should spacetime be equal to c, to the speed of light. $ds^2 = c^2dt^2$?

Can one view equ (12) for the present now? Of course, then there is my equation for two moments in time:

$$ds^2 = c^2dt^2 = S$$

$$= \int_{m_{(t_1)}}^{m_{(t_2)}} Ldt\phi[(E^2 \pm = (p^2c^2 + m^2c^4))]t_{1past}$$

$$\Rightarrow \phi\phi[(E^2 \pm = (p^2c^2 + m^2c^4))]t_{2present} \qquad (13)$$

ds is space-time, L the Lagrandian, the terms $m(t_1)$, $m(t_2)$ is the mass of an object through time in the integral - for mass of an object into the past, one simply reverses these terms in the integral. I think I have now found an equation for the mass of an object in the present compared to the same mass of the object in the past. $E^2 \pm = (p^2c^2 + m^2c^4)$ is the total energy of the mass. This expression was derived by Einstein; p is momentum. Einstein dropped p^2c^2 which he derived $E = mc^2$.

The above equation (13) says that the speed of time c^2dt^2 is equal to the action S of the mass through time $m(t^1)$, $m(t^2)$ from the past to the present with the Lagrandian L, here we have the total energy $E^2 \pm = (p^2c^2 + m^2c^4)$ that includes the mass m. The $\pm$ means the total energy of m can be either forward or backward in time. I also wanted to represent the total energy of the mass in the past, compared to what it is in the present. ϕ is a scalar.

The past, present, and future ''nows'', would not exist at the speed of light for c^2dt^2. Is there not a paradox, something is wrong? Why set the speed of time at c! How can one have a passage of time or flow of time if it does not exist at c. How to represent ''now'', in an equation.

''Now'', would become a timeless moment if the speed of time were at c, just as a photon's experience would be. Photons are at rest, where external events are simultaneous from the frame of a photon. 30,000 light years is just a moment for a photon. Is there not a problem of having time at the speed of c. The speed of time must be a temporal speed, not a spatial speed - spatial speed at c time does not exist or is frozen. How would one have an equation for ''now'', in the present moment that distinguishes the past from the future? There is, of course, the equation:

$$\frac{\delta x}{\delta t} = c^2 \qquad (14)$$

This says that causality takes place at the speed of light. Of course, instead one could have from $ds^2 = c^2dt^2$:

$$\frac{\delta x}{\delta t} = c^2dt^2 \qquad (15)$$

But there is the equation:

$$c^2(i\delta t) = x \qquad (16)$$

This equation comes close to an expression for a moment in ''now'' x, of causality, where i is a vector; again, it is all assumed to take place at the speed of light. But as said earlier, the fact that time is considered at the speed of light might lead to paradoxes that time may not exist at the speed of light. I will speculate that the speed of time is faster than the speed of light, that it's superluminal v_s. Then, for an equation of the ''now'' in causality, one can have the equation:

$$v_s^2(i\delta t) = x \qquad (17)$$

And

$$\frac{\delta x}{\delta t} = v_s$$

For equ (17), would not this make $x > 0$. Would not this mean causality is going backward in time? Can this be right if the speed of time is faster than light? But here we're not talking of spatial speed, but of temporal speed of time. What do we mean by temporal speed. Again, one can take equ (12) and write the equation:

$$ds^2 = v_s^2dt^2 \qquad (18)$$

Here, one has substituted c in equ (12) for v_s. Here, the speed of time or space-time is faster than light; it's also noted that gravity might be faster than light and may well propagate into the past. Also there is the belief that there might be 2 flows of time, one into the past and one into the future - if the speed of time is faster than light, and there are 2 time flows, then the fact that the speed of time is faster than light might mean an aspect of the flow of time into the past, with another element of time flowing into the future, which is based on thermodynamics. According to the dual time energy solution:

$$E^2 = m^2c^4 + p^2c^2 \qquad (19)$$

Where the total energy E is the result of the sum of the momentum p and mass m, multiplied by the speed of light c. Being a second-order equation, it is necessary to take a square root, which always produces two solutions, one positive and one negative. This simple property of square roots implies that the solution of energy is always dual: positive $(+E)$ and negative $(-E)$. According to Einstein's special relativity:

1- The positive energy solution $(+E)$ describes energy that diverges from causes located in the past and which propagates towards the future (retarded potentials).
2- The negative energy solution $(-E)$ Describes the energy that diverges from causes located in the future and which propagates backward in time from the future towards the past (advanced potentials).

Equation (13) of my equation has equation (19) in it, which can be forward and backward in time. Instead of c in equation (13), which would be a value of the speed of light of causality, one can replace it with v_s for superluminal speed of time. One can argue that the reason time flows into the past is that the speed of time is superluminal, and the reason time flows in the forward direction to the future is due to thermodynamics and entropy increase, and that also time flows also backward in time also with entropy increase, which was said earlier in this paper.

What is missing from my equation (13) is entropy, so I have added to my equation of the past energy state of a mass, compared to the same energy state of mass in the present, the equation of entropy: $S = Kln(\Omega)$:

$$ds^2 = c^2dt^2 = S$$

$$= \int_{m_{(t_1)}}^{m_{(t_2)}} Ldt\phi\left[\left(E^2 \pm = (p^2c^2 + m^2c^4)\right)\right]t_{1past}$$

$$= S = Kln(\Omega)$$

$$\Rightarrow \phi\left[\left(E^2 \pm = (p^2c^2 + m^2c^4)\right)\right]t_2present \qquad (20)$$

From the equation of entropy, S is the entropy of a system, K is Boltzmann constant 1.38×10^{-23}Joules per kelvin and Ω is the number of microstates corresponding to a given macrostate. So then the energy state of a mass from the past to the present. Notice that the terms for the total energy state within the square brackets of the mass have two solutions, one forward in time, the other backward in time. From a paper [8] 'Emergence of opposing arrows of time' by Thomas Guff, Chintalpati Umashankar Shastry, and Andrea Rocco, one learns that entropy increases also backward in time.

Equation (20) can be written forward in time and backward in time.

The old argument of thermodynamics that there's only one flow of time, that's from the present to the future, that backward time is ruled out because things don't reverse backward in time like a film in reverse, that this is therefore impossible, because things don't come together after being broken. This is a wrong assumption, is a misunderstanding of the nature of time; it's been found in the paper [8] above that entropy not only goes forward in time, but also backward in time. So mass propagating into the past would also have entropy increase.

CONCLUSIONS

This paper has been highly speculative; there are not really definite conclusions to this paper, without repeating oneself, that yes, the ''now'' we all experience allows us to distinguish the past from the future. But if we could perceive the whole of the future and the past, would we not then be able to distinguish the present ''now''. Is this merely psychological, or are our minds unable to perceive the past and future?

The notion that gravity operates through a hyperspace dimension is highly speculative, and regarding the nature of expanding space of the universe, Heisenberg's uncertainty principle in the creation of energy from nothing or the vacuum, must be a clue to the appearance of space from nothing. We are talking about the creation of space and time (a dimension) that has continued from the Big Bang, so when we talk of the expansion of the universe, we might be talking of the ongoing creation of 4-dimensional space-time. That part of the problem in General Relativity is that the total EMT (energy momentum tensor) does not contain the EMT of the gravity field, which has led to problems. That Mach's principle applied to the repulsive gravity of the vacuum ZPF or dark energy, might follow an inverse square law, increasing in strength the further the distance.

In special Relativity, space is regarded as static, but it's known that in terms of cosmic distances, distant galaxies have recessional speeds faster than light. If space, the vacuum ZPF is regarded as a Machen cosmic reference frame, then this reference frame is receding from us faster than light. For cosmic distances, one knows that space can expand faster than light, and no violation of special Relativity, but that the galaxies are carried by expanding space, have a speed faster than light, is a violation of special Relativity. That the expansion of space might follow an inverse square law, and regarding local distances in our galaxy, that space can be treated as static, with no problem with special Relativity, only for cosmic distances is the speed of light violated by expanding space.

Regarding the superluminal expansion of the universe, would it cause causal violations? All one can say on this is, if the energy of the vacuum ZPF, its repulsive gravity (dark energy) does work to increase the expansion of space, faster than light, would that energy (being faster than light) propagate into the past, is still highly speculative?

Regarding the speed of time, considering that it's at the speed of light, might lead to the paradox that time does not exist at light speed? One here has to distinguish between spatial speed and temporal speed. Travelling at c through space, time stops or does not exist, but travelling at temporal speed at c would time stop or not exist? One does not conclude yet over this, only to speculate that the speed of time might be faster than light. One writes out an equation for the comparison of the energy state of a mass in the present and in the past, including entropy of the system, that entropy can go backward in time, just as it can go forward, and that one's equation can be for the energy of mass going backward in time, as well as forward in time.

That applying Mach's principle to dark energy or a repulsive gravity of the vacuum ZPF, to the spin of galaxies, unlike normal objects rotating, feeling the inertial gravitational effects of distant matter attractive, but for dark energy, the rotation of galaxies might have negative inertia. It would be a repulsion of galaxies away from each other, the further away they are from each other, and that this might follow an inverse square law of dark energy. This is the gravity of the vacuum, known as dark energy, that causes the expansion of space. Such a gravity is repulsive and might be mistaken for dark matter in explaining the rotation curves of galaxies, whose spin might not be due to dark matter but due to dark energy?

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