

Virtual Gravity and the Duality of Reality

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It is shown that a hypothesis about gravity having a virtual cause implies there are two primary reference frames, a reality and a functional virtual reality and an equivalence principle relating the two is postulated. A mathematical expression relating the primary reference frames to the state of reality provides an explanation of particle-wave duality and resolves the controversy about the speed of gravity. A model for motion, time and particle formation is briefly discussed, in which the hypothesis about the virtual cause of gravity and supporting postulates are valid. It is further shown that such model provides solutions to unsolved paradoxes and a unification of consistent but contradictory ancient theories of matter and motion. Finally, a reference is made about the basis for devising experiments and testing the predictions of the model.

1. Introduction

The lack of an explanation about the cause of gravity is well known and there is no need to elaborate in depth on this issue here. It suffices to say that although several hypotheses about the cause of gravitation have been proposed, so far none has been verified experimentally. A few mathematical models of gravitational effects have attained the status of a scientific theory due to their accurate predictions. Two examples of scientific theories about gravity are Newton's Universal Law of Gravitation and Einstein's General Relativity Theory. Van Flandern has provided an excellent introduction on this subject in the book *Pushing Gravity*. [1] Van Flandern is a proponent of Le Sage's model of gravitation based on a material flux of gravitons while recognizing the severe implications from not specifying an antecedent cause to gravitational effects. The model of gravitation based on a material flux of gravitons represents a serious attempt to salvage the reality of this world and stir away from the inevitable conclusion of our reality being some special type of virtual reality. However, the postulations made regarding the properties of the material flux of graviton particles leave no room for an experimental detection and the theory is not falsifiable although its mathematical predictions closely match those of General Relativity. It could be stated that, in an ironic way, the postulations required for turning the graviton material flux into a scientific theory of

gravitation result in it transformed into a virtual cause. It is important also to realize that General Relativity provides a consistent mathematical theory for gravitational attraction based on the concept of curved space-time but it does not define a mechanical cause for the bodies to follow the geodesic paths postulated.

In section two we consider the hypothesis that gravity is the result of a virtual cause and in section three examine the implications arising from it. Based on such implications leading primarily to the concept of the dual nature of our reality, a model is briefly described in section four that can facilitate virtual causes for gravitation and motion. It is further shown in section five that such model provides a solution to the paradoxes of motion and in section six a reference is made to the basis for devising experiments for testing some predictions of the model.

2. Gravity as the Effect of a Virtual Cause

We begin with the hypothesis that gravity has a virtual cause. This hypothesis implies that we inhabit some type of virtual reality. The term *virtual* is often used to denote the state of being such without actually being such. According to this definition, a virtual reality is the state of being a reality without actually being a reality. This definition of virtual reality assumes that observers situated in it can differentiate it from an actual reality. It is not a useful definition for observers situated in a virtual reality without having knowledge of the existence of an external reality causing their virtual reality.

In order to arrive at a more useful definition of virtual reality with virtual gravitational cause, let us consider an intelligent observer who is situated in a virtual reality reference frame. Let us further assume that this observer does not have any knowledge of the existence of a reality reference frame responsible for her virtual reality but has freedom of interaction within the limitations set in her virtual reality. What type of a reality is that for the observer?

In order to answer the question, we note that for the particular observer considered, her reality cannot be considered by her as a virtual reality, since she has no way of knowing or proving that there is another reality responsible for her reality. Then, the reference frame of the observer must be considered part of some reality reference frame from her point of view, for it would make no sense to consider it being a virtual reality, since that's the only reality that appears to exist. Therefore, any virtual reality where there is no direct evidence from the phenomena of an external reality causing it to exist is considered to be a reality.

The above conclusion seems almost trivial. A complication arises, however, when the observer in her virtual reality, which she assumes to be a reality, notices certain interactions that seem to lack a detectable mechanism of cause and effect. As an example, despite her intense efforts, the intelligent observer may consistently fail in identifying the nature of the

mechanism that causes objects to fall towards the ground when dropped from a height above it. The observer may postulate that there must be some type of mechanical interaction, similar to that responsible for the orbits of the planets and comets. Furthermore, when the observer pushes objects they move and she may further postulate that this is the effect of her exerting a force on the objects. In the same context, she may postulate that what holds her on the surface of her planet must be due to some type of force applied on her and this force is transmitted in space. She may then start making hypotheses about the mechanism of gravity being a type of magnetic pulling or something like a pressure coming from above, just to state two alternatives. Apparently, the observer is not aware she resides in a virtual reality reference frame where interactions may be due to virtual causes and a direct transfer of information from a virtual cause to its effect, or vice versa, is not required. In other words, the cause for some phenomena in a virtual reality may be of a virtual nature. In order to describe the type of virtual reality where interactions are possible and in such a way as to offer a perception to intelligent observers of it being a reality, the following definition is made:

Definition: A functional virtual reality is the type of reality where there are some cause and effect interactions that are of virtual nature, in the particular sense that there is not any energy transfer between a virtual cause and its effect.

From the reference frame of a local observer in a functional virtual reality it is irrelevant whether energy is transferred from a virtual cause to its effect or an equivalent amount of energy is used by an external reality facilitating her virtual reality to cause a virtual effect. Thus, a local observer cannot differentiate between reality and virtual reality from a causality perspective. In such cases, describing an effect using hypothetical virtual causes may allow suitable physical laws to be developed. Therefore, one could postulate that there is equivalence between reality and virtual reality in the particular sense described by the following *equivalence principle of reality and virtual reality*:

A functional virtual reality that allows devising physical laws in terms of virtual quantities is equivalent to a reality and can be treated as such.

By treating a functional virtual reality as a reality is meant here that certain physical laws are possible to establish, which describe effects in terms of causes that are of virtual nature. This allows making accurate predictions about dynamical states in a functional virtual reality without the need for an explicit description of the mechanism of the interactions. An example is Newton's Law of Universal Gravitation, which is used in making accurate predictions in the absence of relativistic effects. More importantly, this type of law allows treating a virtual reality as a reality in a larger scheme of things. In terms of causality, a virtual cause can be assumed to act instantly and that can justify *action at a distance*, whereas a real cause must always precede its effect. By postulating virtual causes, the stretched causality relationship implied by physical laws such as the Newton's second law of motion is justified.

Furthermore, the use of force is also justified in this respect, as it is known that many philosophers and scientists criticized the use of force as a pure intellectual construction as soon as Newton published his second law of motion. [2]

Below we summarize the postulates made in supporting the hypothesis that gravity has a virtual cause:

Hypothesis: Gravity has a virtual cause

Postulate 1: There are two primary reference frames, a reality and a functional virtual reality.

Postulate 2: Every effect in a functional virtual reality reference frame has an antecedent cause or a virtual concurrent cause.

Postulate 3: There is an equivalence of reality and functional virtual reality in the particular sense expressed by the equivalence principle of reality and virtual reality.

Next, we will examine some implications arising from postulate three, the principle of equivalence of reality and functional virtual reality.

3. State of Reality and Duality

The postulated presence of two primary reference frames implies a direct relationship between reality and functional virtual reality and also the duality of physical elements. The duality arises because (A) reality is responsible for the existence of functional virtual reality and (B) all elements in a functional virtual reality also exist in reality but not necessarily in the same perceived form. An example is light. In a functional virtual reality light can be considered to be a wave. In the reality reference frame, light is made of particles as will be defined in the model presented in section four of this paper.

3.1 Expected state of reality

The relationship between the two primary reference frames give rise to the notion of a state of reality of observers and postulated to have the following mathematical form:

$$S_R = [1-(1/\gamma)] R_s + (1/\gamma) VR_s \quad 1-1$$

where S_R is the state of reality of the observer, R_s is the state of reality for observers in the reference frame of reality, VR_s the state of reality for observers in the reference frame of functional virtual reality and γ the relativistic *gamma* given by:

$$\gamma = [1 - (v^2/c^2)]^{-1/2} \quad 1-2$$

where v stands for the speed of the observer and c is the speed of light.

It can be seen from expressions 1-1 and 1-2 that the state of reality S_R is ultimately decided by the speed v . For an observer at rest γ is equal to unity and equation 1-1 yields $S_R = VR_s$, that is the observer's state of reality is due to the functional virtual reality VR reference frame only and independent of the state of reality R_s . As the speed of the observer approaches the speed of light, γ approaches infinity and S_R approaches the state of reality R_s attributed to the reference frame of reality R. In effect, an observer travelling at a speed of light c is always a part of the reality reference frame R. At speeds greater than zero and less than the speed of light c , the reference frames of reality R and functional virtual reality VR are connected by equation 1-1 and ultimately decide the state of reality S_R of the observer. From another perspective, equation 1-1 tell us that the state of reality of an observer in a functional virtual reality reference frame VR will change to that of reality R if the speed of light is reached. Therefore, an observer in a functional virtual reality reference frame VR either can never reach the speed of light or if such speed is reached, a permanent change in state of reality occurs to that of reality R.

3.2 Particle-wave duality

Equation 1-1 can be used to describe the particle-wave duality property of light. As a first step, equation 1-1 is used to express the fundamental quantity of mass as follows

$$m = [1-(1/\gamma)] m_p + (1/\gamma) E/c^2 \quad 1-3$$

where the mass m of a particle was substituted for the state of reality S_R in equation 1-1, m_p is the mass of the particle in the reference frame of reality R and E/c^2 the equivalent mass of the particle in the functional virtual reality frame VR. At rest, the speed of the particle is zero and its mass m is given by equation 1-3 and equals E/c^2 . As the speed of the particle approaches the speed of light, γ approaches infinity and its mass m approaches the value defined in the reality reference frame R and given by m_p .

Multiplying both sides of equation 1-3 by the speed of the particle v yields the magnitude of its momentum P :

$$P = mv = [1-(1/\gamma)] m_p v + (1/\gamma) (E/c^2) v \quad 1-4$$

Equations 1-3 and 1-4 illustrate the particle-wave duality property. In the functional virtual reality reference frame VR, light is perceived as a wave and because its speed is constant and equal to c , the second term of the right hand side of equation 1-4 reduces to $P = E/c$. As the speed of the observer approaches c , the primary reference frame becomes that of that of reality R where light has a particle nature. At any intermediate speed, light has a dual nature depending on the reference frame the observer assumes. The constancy of the speed of light is justified by the argument that when part of the reality reference frame R, no physical

magnitude can be affected by interactions taking place in the virtual reality frame VR because reality causes functional virtual reality and not vice versa. Furthermore, physical laws can be devised using either nature of light, whichever is deemed appropriate depending on the reference frame assumed.

3.3 The speed of gravity

An additional postulate is made (Postulate 4) that the speed of information propagation is practically infinite within the reference frame of reality R and limited by the speed of light within the reference frame of functional virtual reality VR. The speed of gravity v_g can be expressed using equation 1-1 as follows:

$$v_g = [1 - (1/\gamma)] v_R + (1/\gamma) v_{VR} \quad 1-5$$

where v_R is the speed of information in the reality reference frame R and v_{VR} the speed of information in the functional virtual reality reference frame VR. At rest, or at speeds much lower than the speed of light, the speed of gravity is approximately equal to the maximum speed of information within the functional virtual reality VR and equals c . In the reality reference frame R, the speed of gravity is many orders of magnitude faster than the speed of light. The speed of gravity as given by equation 1-5 depends on the speed of the observer v included in the gamma factor (equation 1-2) and it is not a constant.

The subject of the speed of gravity is a controversial one but that may only be due to the different reference frames of reality assumed in the calculations and observations made. The Newtonian interpretation of gravity as an attractive force assumes an infinite propagation speed for it and “action at a distance”. Therefore, in the context proposed herein, Newtonian gravity assumes the reference frame of reality R. Special Relativity placed an upper bound on the speed of information transfer, including the propagation of gravity forces in the force field interpretation of General Relativity, equal to that of the speed of light and in the context of this paper assumes the reference frame of virtual reality VR. If gravity propagates at the speed of light, inconsistencies arise in classical Newtonian gravity models, as well as in models that postulate gravity as being the effect of a material flux, such as La Sage’s pushing gravity hypothesis. At the same time, if the speed of gravity is a faster than light (FTL) phenomenon, a serious causality problem arises in General Relativity theory and other metric theories of gravitation.

Recent work based on experimental observations made by Dr. Sergei Kopeikin, a University of Missouri physicist, and Edward Fomalont, an astronomer at the National Radio Astronomy Observatory (NRAO), measured the speed of gravity equal to the speed of light. [3] The publication of the results started a heated debate immediately by dividing scientists in two opposing camps, those asserting that the speed of gravity equals the speed of light and those rebutting such claim and asserting that gravity propagates at much higher speeds. Some have also claimed that the determination of the speed of gravity made by Kopeikin was based

on wrong formulations.

In the context of equation 1-5, the answer about the speed of gravity satisfies both camps. This issue arises because different reference frames are assumed. General Relativists consider the reference frame of the effect of gravity whereas Newtonian force field interpretations of gravity take the reference frame of the cause of gravity. Since both theories fail to define a true cause and effect relationship, then according to the hypothesis made herein, they are both correct about the speed of gravity. The cause of gravity is in the reference frame of reality and operates at speeds practically infinite while its virtual effect can only be observed at the speed of light, which is the upper limit that bounds our entire observations and motion in the functional virtual reality reference frame. The information transfer in the reference frame of reality R is an FTL phenomenon but such operation is transparent to all observers in the functional virtual reality VR it facilitates. In the functional virtual reality reference frame, the phenomenon of gravity can only be observed at the upper speed limit of motion, which is the speed of light. From this specific reference frame and state of reality the speed of gravity depends on the speed of light and given by equation 1-5. There is no causality violation because the reference frames for the cause and effect considered are different and this is a key point. It is important to clarify that according to the hypothesis made herein, gravity is the real effect of a virtual cause in the functional virtual reality reference frame VR and a virtual effect of a real cause in the reality reference frame R . There is no direct cause and effect relationship possible to establish and that has been the main factor contributing to the failure in identifying the mechanism responsible for gravitation.

Equation 1-1 can be extended to account for a variety of physical magnitudes and can express their dual nature arising from the two postulated reference frames of reality, R and VR . From the perspective of a probability distribution of the state of reality, $1/\gamma$ can be thought of as the probability of the state of the observer and equation 1-1 gives the expected value of such state. The state of reality R_s is the null event with probability zero and the state of virtual reality VR_s the certain event with probability one.

3.4 Indeterminacy: Continuity versus Discontinuity

Physical magnitudes in dynamical motion in a functional virtual reality reference frame are considered continuous. In the reference frame of reality, all physical magnitudes are discontinuous at Plank scale, according to the model discussed in the next section. The assumption of continuity of physical magnitudes in a functional virtual reality implies the indeterminacy of such magnitudes. This indeterminacy is due to the application of the set of real numbers R in measuring physical magnitudes and it is known this set is uncountable and that most real numbers are irrational. In the reality frame R , space-time is discrete and the set of rational numbers Q applies. This set does not contain any irrational or transcendental numbers but only numbers with a finite or periodic decimal expansion. With respect to

number sets and their use in measuring physical magnitudes, equation 1-1 can be written as follows:

$$S_I = [1-(1/\gamma)] I_{VR} + (1/\gamma) I_R \quad 1-6$$

where S_I is the state of indeterminacy, I_{VR} the state of indeterminacy in a functional virtual reality reference frame and I_R the state of indeterminacy in the reality reference frame. In the functional virtual reality reference frame VR and at speeds much lower than the speed of light c , the relativistic γ is close to unity and the set of real numbers R applies to all measurements made because of the assumed continuity. As the speed approaches the speed of light c , space-time assumes its discrete nature at the Plank scale level and the set of rational numbers Q can be used in determining physical magnitudes. There is always indeterminacy in physical values due to the applicability of two different sets of numbers with different properties, as expressed by equation 1-6. In the reality reference frame R, measurements are limited by decimal expansion periodicity and in the functional virtual reality frame VR limited in addition in the context of irrational and transcendental numbers. Only at speeds exactly equal to the speed of light there can be a higher precision in the determination of physical magnitudes. This leads to a revision of a recent bold hypothesis made by Lynds of indeterminacy versus discontinuity and presented as a conclusion of an argument that was nevertheless trivially invalid. [4] The same hypothesis is arrived at here within the framework established by the postulate of the presence of two primary frames of reference, a reality R and a functional virtual reality VR but with a notable revision. Certainty is traded off for realizing continuity for observers in the reference frame of functional virtual reality VR and naturally there is not a precise instant in time for physical magnitudes to be determined exactly in that frame. However, the hypothesis is also true in the case of absolute rest in a functional virtual reality and not limited to dynamical motion. Furthermore, any ramifications of the hypothesis of indeterminacy versus discontinuity depend on the reference frame of the observer and if such reference frame is that of reality R, where motion is discontinuous and comprised of precise instants in time, indeterminacy is still present. Therefore, the hypothesis of indeterminacy versus discontinuity alludes to a physical law justified within the context of the equivalence principle of reality and virtual reality previously discussed and holds only for observers in a functional virtual reality who assume a continuous space-time. As the speed of observers in a functional virtual reality VR approaches the speed of light, their state of reality changes to that of reality R_s according to equation 1-1 and certainty increases. This may be contrary to common sense but because the discrete nature of space-time comes into a dominant play at such speeds, continuity vanishes in favor of a discrete space-time but indeterminacy is still present. Indeterminacy is not the cause of either continuity or discontinuity but just an effect. According to the postulation made herein then, the overall effect of indeterminacy of physical magnitudes is, at the highest level, due to the presence of two reference frames of existence with their states related mathematically by expression 1-1 and it is an effect caused by both continuity and discontinuity. Evidently, such mathematical relationship could also prove valuable in making

a more general hypothesis about the structure of physical reality, as attempted in the following section.

4. A Model of Functional Virtual Reality

The four postulates referenced in the previous section are used next as the basis for constructing a model of functional virtual reality VR. Such model must support the original hypothesis about gravity having a virtual cause and, specifically, gravity being a virtual effect of a real cause, in the reference frame of reality R and a real effect of a virtual cause in a functional virtual reality reference frame VR. It should be clear that any such model represents a bold hypothesis as related to the nature of our physical reality and is a purely metaphysical claim at this stage.

4.1 A Model of space and particle formation

The reference frame of reality R is postulated as a supersolid 3-Dimensional medium made of a discrete element with dimensions equal to Plank length. This discrete element, called the *ilikon* (from the Greek work for substance), can assume two binary states, 1 or 0. Binary state 1 is called a *kirion* (from the Greek word for occupant) and corresponds to mass. Binary state 0 is called a *kenon* (from the Greek word for void) and corresponds to empty space. A *kenon* is not a void in the traditional sense but the binary state of a supersolid element, the *ilikon*.

The reference frame of the functional virtual reality VR is the set of the binary states of the discrete elements, or the *kirions*, of the supersolid medium. VR is essentially a dynamic 3-D binary matrix. According to the model, the reference frame of reality R acts as a giant digital processor/medium and all particles are made of the same basic element, the *kirion*. As an analogy, one may consider a digital computer with a central processing unit, memory, input/output and screen display forming a single module. What occurs on the screen also serves as part of the stored program and memory. In the functional virtual reality reference frame VR, the operations taking place, such as the motion of particles, are controlled by the digital processor/medium.

The frequency at which *ilikons* are maintained in *kirion* binary states is given by:

$$f = c/L_i = 2.997 \times 10^8 \text{ m/s} / 1.61 \times 10^{-35} \text{ m} \cong 1.85 \times 10^{43} \text{ s}^{-1} \quad 1-7$$

where L_i is the length of the *ilikon* and equal to Plank length. The inverse of the frequency, T_r , is the upper limit for the time taken to “move” a *kirion* to an adjacent *ilikon*. In a more relevant sense, the time for a *kirion* to seize to exist at a given *ilikon* an appear at an adjacent one and is given by:

$$T_r = 1/f = 1/1.85 \times 10^{43} \text{ s}^{-1} \cong 5.39 \times 10^{44} \text{ s}$$

1-8

and that is equal to Plank time. As a result, according to the model, the binary states of whole universe "refresh" at the frequency of about 10^{43} cycles/second and this refreshing mechanism is part of the reference frame of reality R.

Particles are defined as 3-Dimensional arrangements of *kirions* and are subsets of the binary matrix defining the functional virtual reality reference frame VR.

4.2 Model of motion and time

Motion in the functional virtual reality VR is accomplished by determining the discrete time sequence to affect the binary state changes required in order for the *kirions* of a particle to move successively to adjacent *ilikons* and in a way compatible with the objectives of motion. In this sense, motion is defined as a sequence of binary state changes of *kirions* in discrete time. The primary task of the processor/medium of the reference frame of reality R is in determining the sequence $S\{t_i\}$ of discrete time intervals given the conditions affecting motion. In the reference frame of reality R, such sequence can be determined to a high precision since space is made of discrete increments. Therefore, *the timing of motion gives rise to time* and the primary function of the processor/medium is in determining the former. Motion and time is the outcome of a universal timing mechanism that accounts for every change taking place in the virtual reality frame VR due to particle presence and motion.

As an example, let us consider the case of 1-D uniform linear motion of a *kirion*. The time between any two consecutive binary state changes of the *kirion* to a *kenon*, or vice versa, is the ratio of the *ilikon* length to the required constant speed v and given by $t_i = L_i/v$. In this case, the time interval sequence $S\{t_i\} = \{L_i/v, \forall i\}$ is constant and independent of the distance traveled. The time interval t_i cannot exceed the upper limit imposed by the speed of light, given by equation 1-8. If v could exceed the speed of light, orderly motion cannot take place since the timing mechanism of the processor/medium cannot operate at speeds higher than the speed of light. The maximum speed for orderly motion is restricted by the upper limit imposed by the speed of light and if there are conditions leading to a speed higher than that, motion becomes chaotic and particles disintegrate, losing their configuration that is determined by the spatial arrangements of their *kirions*.

Under conditions of accelerated motion the task of the processor/medium is in determining the appropriate timing sequence for changing the binary states forming particles from *kirions* to *kenons* and vice versa, in a way compatible with the objectives of the motion and the structure of the particle.

The highest acceleration possible is when a *kirion* at rest attains the highest possible speed at the lowest possible time given by equation 1-8. In this case, the maximum acceleration a_{\max} is given by

$$a_{\max} = c/T_r = c^2/L_I \quad 1-9$$

which gives the approximate figure of $0.6E60 \text{ m/s}^2$ for a_{\max} . By multiplying both sides of the equation for a_{\max} by the mass of a particle m , we arrive at the equation $E=mc^2$ in terms of the maximum acceleration possible and the size of the *ilikon* L_I as:

$$E = mc^2 = L_I m a_{\max} \quad 1-10$$

and it is also equal to the energy stored in the particle. This represents the highest amount of energy that can be released by a particle of mass m when disintegrating due to an applied acceleration at a rate that causes its speed to exceed the speed of light.

4.3 Gravity

Gravity in a functional virtual reality reference frame VR is the effect of a cause in the reality reference frame R. The reality reference frame R includes a processor/medium by means of which mass formation and motion in the functional virtual reality are possible. The cause of gravity in Newtonian Mechanics was attributed to the mutual attraction of particles, in Pushing Gravity theory to a sea of a material flux of gravitons where the particles are immersed and in General Relativity to the curvature of space-time. In essence and according to the model presented herein, in all those “reality salvaging attempts” the functions of the processor/medium causing gravity effects were attributed partly or in whole to the elements affected. However, according to postulate three stated in section three, treating a functional virtual reality as a reality using virtual causes allows devising models of gravitation able to make accurate predictions within their specific framework.

For the purpose of getting a better mental description of virtual gravity causes, let us first consider a pure virtual reality manifested in a medium of some sort where some type of bi-directional coupling mechanism is used to transfer information to and from an external reality. The processor situated in the external reality uses the information to determine the operations to take place and sends the appropriate information to the medium via the coupling. In this example, let us consider a mass m_2 that is on an elliptical orbit around a larger mass m_1 . The task of the processor is in determining the position vector of the orbiting mass according to Newton’s Law of Universal Gravitation.

This type of virtual reality is easily constructed nowadays with the help of a digital computer, or even a small handheld programmable calculator. The medium of operation is the screen of the computer and the rule processor the central processing unit. The coupling is just the wiring going from the processor/graphics card to the screen and properly addresses its pixels.

A model of gravitation in a functional virtual reality is considered next. The primary difference between the functional virtual reality and pure virtual reality of the previous example is that the medium is also acting as the processor and incorporates the bi-directional

links between the particles and the processing of information. In essence, the reality reference frame is the medium of operation, or in another sense the “screen”, where matter formation and motion in a functional virtual reality take place.

In this type of functional virtual reality, a planet of mass m_2 will orbit a star of mass m_1 according to an inverse square law for acceleration. An observer in the functional virtual reality reference frame may hypothesize that the orbit is not just a pure geometric effect of a mechanism that is transparent and hidden in the medium but an effect of some real cause, such as for instance a transmitted gravity force. Such hypothesis will lead the local observer nowhere, since a search for a mechanism for the transmission of such force will prove futile. It may be just enough for the local observer to discover the orbit rule using a geometric analysis and then use it for making predictions, as Newton did, while calling such activity science and the failed search for the cause metaphysics. Still, there is a price to be paid and any hypothesis made about the existence of a force or some other cause will embark this observer in a chase of phantom physical causes and probably lead in the establishment of physical laws having several equivalent interpretations. It is nevertheless an achievement for a local observer in a functional virtual reality type of a world to discover a law that is universal and produces accurate predictions about the motion of celestial bodies and artificial satellites, as well as, projectiles and motion under free fall.

The same sort of example can be drawn about free fall, which is another effect of the virtual cause of gravity in a functional virtual reality. In this case, mass m_2 does not attain a closed orbit around mass m_1 but undergoes a free fall from an initial height away from it. In a functional virtual reality the medium/processor will determine the timing sequence necessary to produce acceleration of mass m_2 towards mass m_1 according to the law of universal gravitation. There is no actual energy transfer or force of any kind pulling or pushing mass m_2 towards mass m_1 . According to the model presented here, the medium internal coupling mechanism will affect a change in the position of the *kirions* of the particle m_2 in accordance to the timing sequence and other rules. The binary state change of the *ilikons* involved in the particle formation in time intervals determined by the rule processor achieves the operation of free fall. Again, a local observer may interpret free fall as an operation caused by the existence of some type of a force field, for example, and device laws in such a way as to describe it as an effect of the assumed cause. The local observer in a functional virtual reality seems to have plenty of freedom in making all sorts of assumptions about the nature of the virtual cause of gravity in an attempt to describe it as a real cause in the reference frame of functional virtual reality. In section three it was postulated that this freedom is due to the principle of equivalence of reality and virtual reality based on which the functional virtual reality is designed to operate.

Recall that equation 1-1 yields that observers at absolute rest have a state of reality not affected by the reference frame of reality R and therefore, such observers either do not exist or if they can exist in a functional virtual reality VR, they are not affected by reality R. This

realization arising from equation 1-1 may explain why it is impossible to establish inertial reference frames at absolute rest, measure absolute speed or determine the presence of a space medium, historically referred to as the ether. It also leads to the speculative hypothesis that particles at absolute rest are not affected by causes manifested in reality R and if gravity is a virtual effect of a real cause in the reality reference frame R, such particles are not affected by gravity. Nevertheless, in the absence of a detectable inertial reference frame at rest, establishing conditions of absolute rest could be difficult, if not impossible and a further reference to this will be made in section six dealing with the testability of the model.

5. Paradoxes of Motion Resolved and Theories Unified

The model presented in section four and based on the concept of a supersolid processor/medium made of a discrete element allows a solution to Zeno's paradoxes of the Dichotomy, Achilles and Arrow. The solution is primarily due to motion and time being discontinuous in the reference frame of reality R, which is responsible for the existence of the functional virtual reality reference frame VR. The motion of particles is accomplished, according to the model, by *ilikons* changing from *kirion* to *kenon* states and in such a way as to preserve a particle's configuration while it occupies another place in the *ilikon* space medium. A simple analog of such operation is the way computer graphics is generated using mathematical algorithms on a computer screen. The screen is made of an array of pixels and each time a move is made the appropriate pixels are turned on or off and in such a way as to reflect motion and preserve the viewing perspective of the observer. In the model proposed in section four, there is no actual motion taking place but such phenomenon is the effect of a sequence of binary state changes of *ilikons* in discrete time determined by the processor/medium. In such a model of time and motion, timing of binary state changes gives rise to time being the primary physical quantity and motion, as well as all other physical phenomena, is the result of such timing. In this context, one of the fundamental functions of the universe in such model is that of timing the changes to be affected in the relative position of particles.

The paradoxes of the Dichotomy and Achilles are unsound in the context of the model because the premise used by Zeno involving infinite divisibility is false. The model provides a solution to the Arrow paradox because although space-time is discrete, there is no actual motion taking place but such phenomenon is the effect of binary state changes. Therefore, any void present between successive discrete positions does not inhibit motion.

Zeno's paradoxes were the outcome of an attempt to understand the phenomenon of motion, which has a virtual cause in the functional virtual reality reference frame, as one being a part of a reality reference frame with a real cause. In essence, Zeno and his teacher Parmenides were correct in their conclusion that motion is impossible in an infinitely divisible space-time model or in a discrete space-time model with a pure cause and effect relationship (as opposed to a stretched causality, which holds between virtual causes and their effects).

From an ancient philosophy perspective, the model presented in section four combines in a certain sense Parmenides' Monism with Anaxagoras' Pluralism and Democritus' Discrete Atomism. Evidently, the unified framework offered by the model is what provides a solution to Zeno's paradoxes by introducing the concept of the duality of the state of reality. Plurality is possible because although the universe is made out of a single element, an unlimited number of different particles can form. These particles can be thought of as indivisible in the sense of the Atomists. The Pluralist's notion of infinite divisibility can be then justified in the sense of the equivalence principle of reality and virtual reality applied when one attempts to model a functional virtual reality using Euclidean geometry and the Pythagorean theorem, in conjunction with the set of real numbers. If one takes the reference frame of the medium facilitating the functional virtual reality, then Monism is relevant. From the reference frame of the functional virtual reality, both Atomism and Pluralism are justified depending on the perspective. If the perspective is towards the medium, then Atomism is relevant. If the perspective is away from the medium and towards the reality manifested, then Pluralism applies. Evidently, the three theories combined in some sense suggest the unified framework offered by the model of section four but such hypothesis is only sufficient and were not proven necessary.

6. Testability and Falsifiability

Experiments designed to test any predictions arising from the model presented in section five should focus primarily on the following two elements: (1) the processor/medium, capabilities and limitations and (2) the limitation imposed on information transfer in the functional virtual reality.

Although information transfer in the reality reference frame was postulated to have an infinite speed for all practical purposes, there is a maximum rate at which motion can take place. No postulation can be made regarding the rate at which the processor/medium executes instructions (internal clock rate) but it is quite possible such rate is also finite. If that is the case, then there can be some anomalies detected in some effects in the frame of virtual reality that are the result of an instantaneous inability of the processor to determine the timing sequence required to achieve orderly motion in a deterministic system. Such anomalies can arise when in a closed vicinity of space there is a high number of particles in deterministic motion and deviations are detected from expectation. However, devising such experiment could be very difficult. Another way of detecting anomalies could be based on monitoring the output of a number of simple nano-scale digital processors running a deterministic algorithm. These processors could be placed at close vicinity in a high-speed vehicle, such as a rocket or mechanical centrifuge, in an environment where there are other particles free to move under excitation. Any deviation of the output of the processors would indicate a failure of the particles carrying information to accomplish their motion in an

orderly fashion.

If the prediction of anomalies present in the motion of particles in high speed motion due to large scale interactions is true, then this represents a problem for high speed space vehicles re-entering earth's atmosphere. Under some conditions, there can be a local alteration of the composition of the material of those vehicles resulting in a susceptibility to failure under heat transfer conditions. However, it may be hard to realize repeatable experiments under such conditions using pure material compositions, although not impossible, and the experiment based on the detection of anomalies in the output of electronic devices is more realistic to perform.

Another basis for an experiment rests on the postulation of the duality of the state of reality and the hypothesis of section four that particles at absolute rest are not affected by the virtual gravitational cause. This implies that an artificial satellite, or even projectile, under some motion condition may exhibit an anomalous acceleration as a result of the loss of gravitational attraction for a very small interval of time and when relative motion results in an equivalent absolute rest. Incidentally, using such hypothesis for testing the viability of anti-gravity would be very difficult, if not impossible, since it is probably required to expend more energy in establishing protracted absolute rest conditions than actually overcoming gravity. Nevertheless, the hypothesis provides grounds for the falsifiability of the model and improved predictions regarding the motion of artificial satellites and celestial bodies.

7. Conclusion and Comments

Beginning with the hypothesis about gravity having a virtual cause, four postulates were stated that led to the concepts of a functional virtual reality and the duality of the state of reality along with a mathematical expression relating such a state to the functional virtual reality and reality reference frames. It was shown that such relationship satisfies the particle-wave duality, resolves the controversy surrounding the speed of gravity and describes how indeterminacy manifests in dynamical physical magnitudes. The combined conclusions led to the development of a model based on which matter is formed and motion is accomplished while satisfying the original hypothesis about gravity having a virtual cause. It was shown that such a model provides a solution to the paradoxes of motion and a unified framework of competing ancient theories of matter and space-time. Based on the details of the model and the implications arising from the duality of the state of reality on gravity, some suggestions on devising experiments for testing some of the model prediction were offered.

The hypothesis made in this paper represents a bold departure from traditional perceptions of the nature of our reality and could potentially be an unsettling one if verified. However, after the dust settles it will be "business as usual" and what we will be left with is the same world to study and analyze but from a different perspective. It is important to state that this paper

has no religious motivation or implication of any sort. The issues of Creation versus Evolution and Intelligent Design versus Order from Chaos are probably invariant under any conceivable model and a higher level of knowledge outside the reach of any epistemological and ontological inquiry. In this respect, very little can be speculated about the inner workings of the reference frame of reality, as opposed to our reference frame of functional virtual reality, other than from the limited rational epistemic content that is needed to justify the functional virtual reality. Any inquiry about the nature of reality and the laws governing it always reaches a stalemate. Unless there can be a discovery of true premises with a process that goes beyond a syllogistic approach based on deduction, induction or even the abduction of hypotheses. The discovery of such process, if it exists, poses a great challenge and may offer answers to the fundamental questions of cosmology about the origin and structure of reality.

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