

# **Virtual Gravity and the Duality of Reality**

Efthimios Harokopos

## **Abstract**

A hypothesis stating that gravity has a virtual cause leads to the postulation of the presence of two primary reference frames and of a principle of equivalence which relates the two. A mathematical expression, relating the two primary references frames to the state of reality of observers, provides an explanation of particle-wave duality and resolves the controversy concerning the speed of gravity. A model of time, space, matter and motion is briefly discussed, in which the hypothesis regarding the virtual cause of gravity and supporting postulates are true. It is shown that the model provides a solution to the paradoxes of motion and a brief reference is made to experiments for testing some of its predictions.

Keywords: Gravity, Reality, Virtual Reality, Causality, Zeno's Paradoxes

## **1. Introduction**

The lack of an explanation concerning the nature of gravity is well known and there is no need to elaborate on this issue at length in this paper. Suffice it to say, that although several hypotheses regarding the nature of gravity have been proposed, so far none have been verified experimentally. In Van Flandern (2002, 93-95) there is an excellent introduction to this subject with specific reference to causality issues in General Relativity Theory. Van Flandern is a proponent of Le Sage's model of gravitation based on a material flux of gravitons, while recognizing the severe implications of 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 to stir away from the conclusion that our reality is a special type of virtual reality. However, the postulations made regarding the properties of the material flux of graviton particles, leave no room for its experimental detection and the theory is not falsifiable although its mathematical predictions match those of General Relativity.

Ironically, it seems that the postulations required for turning the hypothesis about the graviton material flux into a scientific theory of gravitation, and specifically in terms of the graviton properties such as its mass and speed, result in it being transformed into a virtual cause. It is also important to realize that General Relativity provides a consistent mathematical theory of gravitation based on the concept of curved space-time but does not define a mechanical cause for the bodies to follow the geodesic paths postulated.

In section 2 of this article, I state the hypothesis that gravity is the effect of a virtual cause and in section 3, I examine the implications arising from this. Based on such implications which lead primarily to the concept of the dual nature of our reality, in section 4 a model is briefly described that can facilitate virtual gravitational causes and motion. It is further shown in section 5 that such model provides a solution to the paradoxes of motion, also known as Zeno's paradoxes and in section 6, a reference is made to certain 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 a kind 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 a state of reality, without actually being a reality. This definition assumes that observers situated in virtual reality are able to differentiate it from a reality. It is not a useful definition for observers situated in a virtual reality without their 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 this for the observer?

In order to answer this question, we note that for the particular observer in question, she cannot consider her reality as a virtual reality, since she has no way of knowing or proving that there is another reality responsible for her reality. Furthermore, the observer's reference frame must be considered as part of some reality reference frame from her point of view, for it would make no sense to consider it a virtual reality, since this is 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 by local observers 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 appear to lack a detectable mechanism of cause and effect. As an example, the intelligent observer, despite her intense efforts, may consistently fail to identify 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 a kind of mechanical interaction must be taking place, 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 upon her and that this force is transmitted in space. She may then start making hypotheses about the mechanism of gravity being a type of magnetic pulling or a pressure resulting from a material flux, just to state two alternatives. Thus, the observer is not aware that she resides in a virtual reality reference frame where interactions may be due to virtual causes and a direct transfer of energy from a virtual cause to its effect, or vice versa, is not required in such a frame. In other words, the cause of certain phenomena in a virtual reality may be virtual in nature. In order to describe the type of virtual reality where interactions are possible and in such a way as to offer intelligent observers the perception of it being a reality, the following definition is made:

*A functional virtual reality is the type of reality where there are some cause and effect interactions that are virtual, in the sense that there is no energy transfer between a virtual cause and its effect.*

In the reference frame of a local observer in a functional virtual reality, it is irrelevant whether or not energy is transferred from a virtual cause to its effect or an equivalent amount of energy is used by an external reality facilitating the observer' s 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 permits the devising of physical laws in terms of virtual quantities is equivalent to a reality and can be treated as such.

What is meant by ' treating a functional virtual reality as a reality' in the present context, is that it is possible to establish physical laws, which describe effects in terms of causes that are virtual. This allows us to make accurate predictions concerning 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 makes accurate predictions in the absence of relativistic effects. More importantly, this type of law allows us to treat 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 can justify *action at a distance*, whereas a real cause must always precede its effect. By postulating virtual causes, the stretched causality relationship (concurrent cause and effect) implied by physical laws such as Newton's second law of motion, is then justified. Furthermore, the use of force is also justified in this respect, although it is well-established 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 (see Greenwood 1965, 24-25).

We can summarize the postulates made in support of the hypothesis that gravity has a virtual cause, as follows:

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 3, the principle of the 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 as well as 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 are not necessarily perceived in the same form. An example of this 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 4 of this paper.

#### *The state of reality*

The relationship between the two primary reference frames gives rise to the notion of a state of reality of observers and is 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 situated in the reference frame of reality,  $VR_s$  the state of reality for observers situated in the reference frame of functional virtual reality and  $\gamma$  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,  $\gamma$  is equal to unity (see equation 1-2) and equation 1-1 yields  $S_R = VR_s$ , that is the observer's state of reality is due to the functional virtual reality reference frame only and is independent of the state of reality  $R_s$ . As the speed of the observer approaches the speed of light,  $\gamma$  approaches infinity in equation 1-2, and  $S_R$  approaches the state of reality  $R_s$  attributed to the reference frame of reality. In effect, any observer travelling at the speed of light  $c$ , is always a part of the reality reference frame  $R$  according to equation 1-1. 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 related by equation 1-1 and ultimately decide the state of reality  $S_R$  of the observer. Equation 1-1 tells us that the state of reality of an observer situated 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 change in the state of reality occurs to that of reality  $R$ .

### *Particle-wave duality*

Equation 1-1 may 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  $E/c^2$  is the equivalent mass of the particle in the functional virtual reality frame  $VR$ . At rest, the speed of the particle  $v$  is equal to zero and its mass  $m$  is given by equation 1-3 and equals  $E/c^2$ . As the speed of the observer approaches the speed of light,  $\gamma$  approaches infinity and 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  $v_p$ , yields the magnitude of its momentum  $P$ :

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

Equations 1-3 and 1-4 illustrate the property of particle-wave duality. In the functional virtual reality reference frame  $VR$ , light is perceived as a wave and because its speed  $v_p$  is constant and equal to  $c$ , the right-hand side of equation 1-4 reduces to  $P = E/c$  for a speed of the observer  $v \ll c$ . As the speed of the observer approaches  $c$ , the primary reference frame becomes that of reality  $R$ , where light has a particle nature. At any intermediate speed, light has a dual nature, depending on the reference frame assumed by the observer. The constancy of the speed of light is justified by the argument that when it is a 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 the particle or the wave property of light, whichever is deemed appropriate depending on the reference frame assumed.

### *The speed of gravity*

An additional postulate is made (Postulate 4) that the speed of propagation of information is practically infinite in the reference frame of reality R and limited to the speed of light in 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 propagation of information in the reality reference frame R and  $v_{VR}$  is the speed of information propagation 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 that defined in the functional virtual reality VR and is limited by the speed of light  $c$ . The speed of gravity as given by equation 1-5 depends on the speed of the observer  $v$  and it is not a constant. As the speed of the observer approaches the speed of light  $c$ , the speed of gravity approaches the value defined in the reality reference frame R, which is practically infinite.

The subject of the speed of gravity has stirred up plenty of controversy but that may only be due to the different reference frames 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 where there are practically infinite propagation speeds. Special Relativity has placed an upper limit on the speed of information propagation, including that of gravity forces in the 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 models of gravitation, as well as in models that postulate gravity as being the effect of a material flux, such as Le 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 Kopeikin 2003 measured the speed of gravity as being equal to the speed of light. The publication of the results immediately instigated a heated debate by dividing scientists into 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 is based on incorrect

formulations.

In the context of equation 1-5, the answer concerning the speed of gravity satisfies both camps. This issue arose because different reference frames are assumed. General Relativists consider the reference frame of the effect of gravity whereas Newtonian interpretations of gravity consider the reference frame of the cause of gravity. Since both theories fail to define a true cause and effect relationship, according to the hypothesis made herein, both are correct about the speed of gravity. The cause of gravity operates in the reference frame of reality and at practically infinite speeds, while its virtual effect can only be observed in a functional virtual reality to operate at the speed of light. The speed of information propagation 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. From this specific reference frame and state of reality, the speed of gravity depends on the speed of light and is 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 effect of a virtual cause in the functional virtual reality reference frame VR and a virtual effect of a cause in the reality reference frame R. There is no direct cause and effect relationship which it is possible to establish and this has been the key 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 which can express their dual nature arising from the postulated reference frames of reality, R and functional virtual reality VR. As an example, in the next section, this concept is applied to the notion of indeterminacy.

#### *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 Planck 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 that this set is uncountable and that most real numbers are irrational. In the reality reference 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  $\gamma$  is close to unity and the set of real numbers  $R$  applies to all measurements made because of the continuity perceived at the phenomenal level. As the speed approaches the speed of light  $c$ , space-time assumes its discrete nature at the Planck 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, the substance level, measurements are limited by decimal expansion periodicity and in the functional virtual reality frame VR, the phenomenal level, limited in addition by irrational and transcendental numbers. Only at speeds exactly equal to the speed of light can there be greater precision in the determination of physical magnitudes.

This leads to a revision of the bold hypothesis made in Lynds 2003 of indeterminacy versus discontinuity and which was presented as the conclusion of an argument that was clearly a *petitio principii*. The same hypothesis is arrived at here, within the framework established by the postulate concerning the presence of two primary frames of reference, a reality R and a functional virtual reality VR, but with a significant revision. Certainty is traded off against the realization of continuity for observers in the reference frame of functional virtual reality VR and naturally there is no precise static instant in time for physical magnitudes to be determined exactly in this frame. However, the hypothesis is also true in the case of absolute rest in a functional virtual reality and is not limited to dynamical motion and associated precise static instants in time. 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 as postulated in section 4, 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 as has been previously discussed and holds true 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 dominant play at such speeds, continuity vanishes in favor of a discrete space-time although indeterminacy is still present. Indeterminacy is not the cause of either continuity or discontinuity but only the effect of these. According then to the hypothesis made herein, the effect of the indeterminacy of physical magnitudes is, at the highest level, due to the presence of two reference frames of existence with states of reality related mathematically by expression 1-1 and such effect is related to 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 time, space, matter and motion

The three postulates listed in section 2 as well as the additional postulate made in section 3 regarding the speed of information propagation, are next used 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, that gravity is a virtual effect of a cause in the reference frame of reality R and an effect of a virtual cause in a functional virtual reality reference frame VR. It should be clear that the model represents a bold hypothesis as far as the nature of our physical reality is concerned and is purely a metaphysical claim at this stage.

##### *Space and matter*

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 here *ilikon* (from the Greek work for substance), can assume two binary states, 1 or 0. Binary state 1 is called here *kirion* (from the Greek word for occupant) and corresponds to mass. Binary state 0 is given the name *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 element, the *ilikon*, of the supersolid medium. VR is essentially a dynamic 3-D binary matrix. According to this model, the reference frame of reality R is a giant digital processor/medium and all particles are made of the same basic states, *kirions* and *kenons*. 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 state 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 Planck length. The inverse of the frequency,  $T_r$ , is the upper limit for the time taken to “move” a *kirion* to an adjacent *ilikon* and 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 this is equal to Planck time. As a result, according to the model, the binary states of a 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 *kenons* and are subsets of the binary matrix defining the functional virtual reality reference frame VR.

### *Time and motion*

Motion in the functional virtual reality VR is accomplished by determining the discrete time sequence which affects the binary state changes required, in order for the *kirions* and *kenons* of a particle to move successively to adjacent *ilikons* and in such a way that is compatible with the objectives of motion. In this sense, motion is defined as a sequence of binary state changes of *ilikons* 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 timing. Motion and time are the outcomes 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 taken between any two consecutive binary state changes from 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 on it by the speed of light, given by equation 1-8. If  $v$  could exceed the speed of light, orderly motion could not 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 limited to that of the speed of light  $c$  and should there conditions be present leading to a speed higher than  $c$ , motion becomes chaotic and particles disintegrate, losing their configuration which is determined by the spatial arrangements of their *kirions* and *kenons*.

Under conditions of accelerated motion, the task of the processor/medium is to determine the appropriate timing sequence for changing the binary states forming particles from *kirions* to *kenons* and vice versa, in a way that is 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 in the lowest possible time, as 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  $0.58 \times 10^{51} \text{ m/s}^2$  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.

### *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 it was attributed to a sea of gravitons, a material flux in which 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 “reality salvaging attempts” the functions of the processor/medium causing gravity effects are attributed partly or in whole to the elements affected. However, according to postulate three stated in section 3, treating a functional virtual reality as a reality using virtual causes allows the devising of models of gravitation able to make accurate predictions within their specific framework.

In order to better describe virtual gravity causes, let us first consider a pure virtual reality manifested in a medium where a kind 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 which will 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 to determine 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. The medium of operation is the screen of the computer and the rule processor the central processing unit. The coupling is simply the wiring going from the processor/graphics card to the screen which 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 also acts 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 different 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 of 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 a 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 just be enough for the local observer to discover the orbit rule using a geometric analysis and to then use it in making predictions, as did Newton, 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 concerning the existence of a force or some other cause, will cause such observer to embark on a chase of phantom physical causes and will probably lead to the establishment of physical laws which have several equivalent interpretations. It is nevertheless an achievement for a local observer in a functional virtual reality type of world to discover a law that is universal and produces accurate predictions concerning the motion of celestial bodies and artificial satellites, as well as projectiles and motion under free fall.

A similar 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 distance 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 transfer of energy or force of any kind pulling or pushing mass  $m_2$  towards mass  $m_1$ . According to the model presented here, the medium's internal coupling mechanism will effect a change in the position of the *kirions* and *kenons* of the particle  $m_2$  in accordance with 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, observers in VR may interpret free fall as an operation caused by the existence of a gravitational potential, for example, and devise laws in such a way as to describe it as an effect of the assumed cause. Observers in a functional virtual reality seem to have plenty of freedom to make all sorts of assumptions about the nature of the virtual cause of gravity, in an attempt to assign to it a real cause. In Section 2, 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 in VR 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 do exist, 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 detect 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 operating in reality R and if gravity is a virtual effect of a 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 in an experiment could be difficult, if not impossible and a further reference to this will be made in section 6 dealing with the testability of the model.

## 5. A solution to the paradoxes of motion

The model presented in Section 4, based on the concept of a supersolid processor/medium made of a discrete element, solves Zeno's paradoxes of the Dichotomy, Achilles and Arrow (for a description of the paradoxes see for example Salmon 2001; Barnes 1979). 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 are generated using mathematical algorithms on a computer screen. The screen is made up 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 presented in section 4, there is no actual motion and 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 according to the model is that of timing the changes to be effected in the relative position of particles.

The paradoxes of the Dichotomy and Achilles are unsound in the context of the model because the premise involving infinite divisibility is false. Space-time is discrete in the reference frame of reality R, which is responsible for the existence of the reference frame of virtual reality VR. Therefore, all series are finite, have finite limits, and no issue of infinite divisibility is involved. The model provides a solution to the Arrow paradox because although space-time is discrete, no actual motion takes place but such phenomenon is the effect of binary state changes whose cause is found in another reference frame. Therefore, any void present between successive discrete positions does not inhibit motion, since true motion does not exist at the substance level and is only an illusion at the phenomenal level. In essence, motion is accomplished by matter coming in and out of existence at different

locations and at extremely high rates, in a way not noticeable at the phenomenal level.

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 according to the hypothesis made herein, as being one which is part of a reality reference frame with a real cause. So, in fact, Zeno and his teacher Parmenides were correct in their conclusion that motion is impossible in an infinitely divisible space-time, or plenum, or in a discrete space-time model, which requires motion in voids. Apparently, all solutions which have been proposed to this day, have ignored the fact that Zeno's paradoxes were not a challenge to motion at the phenomenal level but at the substance level. Naïve solutions have concentrated on justifying motion at the phenomenal level using the notion of convergent series, limits, or non-standard analysis. The model presented herein offers a solution to the paradoxes of motion at both the phenomenal and substance level by resorting to the hypothesis of the duality of reality, although such solution is only sufficient but not necessary.

## **6. Testability and Falsifiability**

Experiments designed to test any predictions arising from the model presented in section 4 should focus primarily on the following areas: (1) the processor/medium, capabilities and limitations and (2) the limitation imposed on the speed of information propagation in the functional virtual reality.

Although the speed of information propagation in the reality reference frame was postulated to be infinite 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 several anomalies can be 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 are 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 in close vicinity to each another 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 in 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 in the motion of particles in high-speed motion due to large-scale interactions is true, then may present a problem for space vehicles re-entering the

earth's atmosphere. Under certain conditions, there can be a local alteration in 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 4, that particles at absolute rest are not affected by the virtual gravitational cause. This implies that an artificial satellite, or even a projectile, under a specific motion condition may exhibit an anomalous acceleration as a result of the loss of gravitational attraction. This can occur, for instance, when for an infinitesimally small interval of time, relative motion results in an equivalent absolute state of rest. Incidentally, using such hypothesis in order to test the viability of anti-gravity would be very difficult, if not impossible, since it is probably necessary to expend more energy in establishing protracted absolute rest conditions than to actually overcome 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**

Beginning with the hypothesis that gravity has 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 is manifested 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. 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 predictions were offered.

Obviously, there is a limit as to how much we can speculated about the inner workings of the reference frame of reality, as opposed to the reference frame of functional virtual reality, other than from the limited epistemic content that is needed to justify the functional virtual reality. Any inquiry about the nature of reality and the laws governing it, will always reach an impasse, unless there is 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 concerning the origin and structure of reality.

### References

- Barnes, J. (1979), *The Presocratic Philosophers*, 2 Vols. London: Routledge.
- Greenwood, D. T. (1965), *Principles of Dynamics*, New Jersey, Prentice-Hall
- Kopeikin, S. M. (2003), “The Measurement of the Light Deflection from Jupiter: Theoretical Interpretation”, astro-ph/0302462
- Lynds, Peter (2003), “Time and Classical and Quantum Mechanics: Indeterminacy versus Discontinuity”, *Foundations of Physics Letters*, 16(4): 343-355.
- Salmon, W. (2001), *Zeno’s Paradoxes*, 2nd Edition, Indianapolis: Hackett.
- Van Flandern, Tom (2002), “Gravity”, in Matthew R. Edwards (ed.), *Pushing Gravity: New Perspectives on Le Sage’s Theory of Gravitation*. Montreal: Apeiron.