Analog Models, the GGU-model, and Non-secular Applications

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Abstract: Within a substratum, the GGU-model is either a pure substratum secular analog model for processes that produce universes, processes that we cannot otherwise comprehend, or a non-secular model that also generates the General Intelligent Design (GID) Model. Specific analog models, such as Newton's dynamic geometry, are investigated and various GGU-model schemes for the producing universes are discussed. With the exception of intelligent mechanical and linguistic invention via a biological entity such as the human being, our physical universe displays no linguistic information. The problem as to how it is possible that such physical behavior does follow the linguistic descriptions described by intelligent beings, descriptions that do not appear within Nature, is solved.

1. Analog Models.

Certain basic terms used throughout this article are defined in the Internet Reference [A]. For example, this article is written in a "positive" language. It deals with "objects," "models," "objective reality," "observables," and the like. The terms **entity and analog** do not appear in [A]. The term "entity" means a thing that has an individual existence in physical reality or in the mind. That is, an entity can be but a mental construct. The term "analog (analogue)" simply means a type of simplified representation that leads to the rational prediction of observable physical behavior. However, these terms tend to have varying definitions that allow for extended philosophic discussions. The term "object" has its basic dictionary definition, "anything that can be seen or touched," but in scientific practice it is often used as a synonym for entity. For my articles and for a particular science community, the (physical or material) "objects" are accepted observed and defined (named with guessed properties) and predicted unobserved members of our universe.

Secular science considers our universe as composed of material objects. A physical science community names such objects and accepts a list of physical-systems as its foundational area of study. The term "Nature" refers to the accepted material universe with the exception of intelligent mechanical and linguistic inventions via a biological

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entity such as the human being. In this article, rather than rely upon some general definition for model or the term analog, specific examples are given. In general, the term "physical" refers to a finite, but varying, list of terms accepted by a specific group of individuals as naming real entities and also naming properties that are presented in various forms.

2. Infinitely Small, Fluxions and Dynamic Geometry.

After geometry, for the physical sciences and engineering, the most significant mathematical structure thus far developed is the Calculus. The actual calculus is not presented in Newton's major work *The Mathematical Principles of Natural Philosophy* (Newton, 1686), but rather it is found elsewhere in his writings produced within a 20 period prior to this books publication.

Newton's modeling of physical behavior is firmly rooted in his concept of the relation between geometry (the basic mathematical structure of the 1600's) and mechanics. This is his method of **dynamic geometry** - the locus approach.

> "Geometry does not teach us to draw lines, but requires them to be drawn, for it requires that the learner should first be taught to describe these accurately before he enters geometry, then it shows how by these operations problems may be solved. To describe right lines and circles are problems, but not geometrical problems. The solution of these problems is required from mechanics,....therefore geometry is founded in mechanical practice, and is nothing but that part of universal mechanics which accurately proposes and demonstrates the art of measure." (Newton, 1934, (p. xvii))

Newton's claim is that our observations and intuitive comprehension of mechanics comes first in our education. These concepts are then abstracted to include the vague notion that objects have certain "capacities or potentials to do things"- the capacity or potential idea. We are told that it is after experimentation, observation and reflection that the mathematical structure is evoked and these "easy" capacity concepts are modeled.

In Newton, (1686), he gives what he claims is the easily comprehended notion of the "ultimate velocity or fluxions," or what we now term the **instantaneous velocity**, for an actual material object as well as the "ultimate ratio," which is the ratio p/q of two ultimate velocities. He does this via his notion that motion is first "observed" and this yields a collection of positions modeled by geometry and then "numerical" measures associated with geometric concepts are employed. But it is actually in the middle 1600's that Newton utilizes a purely dynamic method to arrive at his geometry. He introduces a new type of dynamics that for some natural philosophers is not related to the material world and needs to be rejected. Unfortunately, some of Newton's actual demonstrations of the more complex geometric concepts, such as curvature, are not valid from the viewpoint of the modern theory of infinitesimals and require slight alterations. When these alterations are conjoined with the modern treatment, then elementary demonstrations are easily obtained and comprehended.

In Newton's paper (Summer, 1665), an algorithm is given that yields the relations between the "fluxions" $p,\ q$ associated with variables $x,\ y$. These variables are related by an algebraic expression that is assumed to generate a geometric configuration. According to Euclid, *these geometric entities do not materially exist but are names given to the mental concept of collections of positions, of systems of points.* In Newton (Newton, Oct. 1665 - May 1666. (1967, (p. 383))) the algorithm is specifically described. How Newton, by observation, arrives at this algorithm and what exactly $p,\ q$ represent is discussed later in his paper. A better explanation of how he formulates his algorithm and the meaning of the term fluxion appears in his Oct. 1666 tract (Newton, 1666). Under proposition 7 (Newton, 1666, (1967, (p. 402))), he explains his algorithm, step by step. After some examples, he discusses how he arrives at this algorithm and what fluxions signify (Newton, 1666, (1967, (p. 414))). First, he considers two "bodies A, B moving uniformly." He lets an algebraic expression $f(x,y) = 0$ represent a relation between the distances traveled by these two bodies.

Then Newton introduces the numerical concept of the distance traveled by a body having uniform velocity p, usually, over a "moment, an instant" of "infinitely small" time o. Newton represents the distance each body travels by the sum of line segment lengths. Body A first travels along $\overline{ac}$ and at the same time body B travels along $\overline{bg}$. Now in an "infinitely small" (infinitesimal) period of time, o, body A travels along $\overline{cd}$ and during the same time interval body B travels along the segment $\overline{gh}$. He states that the motion is not, in general uniform, but it is *"as if the body A with its velocity p describe the infinitely little line $\overline{cd} = p \times o$ in one moment, in that moment the body B with the velocity q will describe the line $\overline{gh} = q \times o$. So that if the described lines be $\overline{ac} = x$, and $\overline{bg} = y$, in one moment, they will be $\overline{ad} = x + p\,o$, and $\overline{bh} = y + q\,o$ in the next."*

Clearly, $\overline{cd}$, in $\overline{cd} = p \times o$, indicates a non-zero infinitesimal measure, a number of some sort and, since he allows ordinary real number arithmetic to be used, his fluxion $p = \overline{cd}/o$. Newton claims that the fluxions p and q are a type of velocity and he proceeds to demonstrate how relations between these fluxions, in particular the relations relative to the quotient q/p, are obtained. It is within this demonstration that a contradiction occurs. Newton writes *"Now if the equation expressing the relation between the lines x and y be $x^3 - abx + a^3 - dy^2 = 0$. I may substitute $x + p\,o$ and $y + q\,o$ into the place of x and y; because (by the above) they as well as x and y do signify the lines described* *by the bodies A and B*. [Of course, this statement would only be true if fluxions or the motion of the bodies is uniform over a <u>standard</u> time interval, o, and the ordinary Galilean physics is applied.] *By doing so there results*

$$x^3 + 3pox^2 + 3p^2o^2x + p^3o^3 - dy^2 - 2dpoy - dq^2o^2$$

$$-abx - abpo$$

$$+a^3 = 0. \tag{1}$$

But $x^3 - abx + a^3 - dy^2 = 0$ *(by supp). Therefore there remains only*

$$3pox^2 + 3p^2o^2x + p^3o^3 - 2dqoy - dq^2o^2 - abpo = 0. \tag{2}$$

Or dividing it by o it is

$$3px^2 + 3p^2ox + p^3o^2 - 2dqy - dq^2o - abp = 0. \tag{3}$$

[Thus, for the algebraic processes of the 1600's, o behaves, with an exception during one point in his deriavtions, like a nonzero real number. Newton goes on to write:] *Also those terms are infinitely little in which o is. Therefore omitting them there results*

$$3px^2 - abp - 2dqy = 0. \tag{4}$$

[This is the exception.] *The like may be done in all other equations.* Newton would then continue and express his important ratio

$$\frac{q}{p} = \frac{3x^2 - ab}{2dy}. \tag{5}$$

Obviously step (4) is not justified and to some, such as Berkeley, contradicts the nature of the infinitely small <u>nonzero</u> quantity o. That is, at one moment it behaves like a nonzero number but at another personally selected moment in a derivation it behaves like zero. For Berkeley, it can have only one mode of behavior.

Notice that using the modern notion of differentiation of $x^3 - abx + a^3 - d'y^2 = 0$ yields $2x^2dx - abdx - 2d'ydy = 0$ and this implies that $dy/dx = (2x^2 - ab)/(2d'y) = p/q$, where Newton's notation requires the substitution of d' for d.

After this, and in other demonstrations, Newton indicates that he guessed at portions of his fluxion creating algorithm by applying steps (1) - (5) to numerous algebraic expressions and making certain observations as to the physical appearance of such equations as (4) and (5). This algorithm, his observation, is claimed to simply eliminate the need to apply continually the above, often criticized, process. Newton repeats similar derivations in his Winter 1670 - 1671 tract as well as suggesting that the delineated process may be applied to relations between three or more variables.

Newton writes:

> "Perhaps it may be objected, that there is no ultimate proportion of evanescent quantities; because the proportion, before the quantities have vanished, is not ultimate, and when they are vanished is none. But by the same argument it may be alleged that a body arriving at a certain place, and there stopping, has no ultimate velocity; because the velocity, before the body comes to the place, is not its ultimate velocity; when it has arrived, there is none. But the answer is easy; for by the ultimate velocity is meant that with which the body is moved, neither before it arrives at its last place and the motion ceases, nor after, but at the very instant it arrives; that is, the velocity with which the body arrives at its last place, and with which the motion ceases. And in like manner, by the ultimate ratio of evanescent quantities is to be understood the ratio of the quantities not before they vanish, nor afterwards, but with which they vanish....For those ultimate ratios with which quantities vanish are not truly the ratios of ultimate quantities, but limits towards which the ratios of quantities decreasing without limit do always converge; and to which they approach nearer than by any given difference, but never go beyond, nor in effect attain to, till the quantities are diminished in infinitum." (Scholium to Lemma XI in Book 1, (Newton, 1686))

What Newton describes is very close to the classical limit notion. However, from his applications and arguments this does not seem to be what Newton truly believes but only a popular exposition that would not offend the geometers of his day. As is well-known Newton was very fearful of criticism and, even though he would use his fluxion methods in private to model physical behavior, he did not perform fluxion computations directly within this all important research document.(Scholium to Lemma XI in Book 1, (Newton, 1686))

Newton considered the notion of time as a type of continuous flowing notion and that there are such things as an "instant" of time. For the case of nonzero instantaneous velocity, one might gather from this the power of Newton's mental vision and his intuitive comprehension of future behavior. Since even though the object may not appear to move at the instant one observes the hands of a clock point at a numerical representation for the time, the object did arrive at a space location and has the capacity to change its position. It is claimed that this indicates where a type of change in position is noted when a second observation is made and the hands of the same clock are assumed to point at a different numerical representation for the time.

Newton assumes that instantaneous velocity is a measure for real physical behavior. This rather abstract notion may be "easy" for Newton to grasp, but it was incomprehensible to Berkeley and many others who believed that such abstractions could not be applied to actual material objects. The paramount philosophy of science for Berkeley was a science of the material and a directly observed universe. Any arguments that relied upon such abstractions would need to be rejected.

From these ideas, Newton also develops the "simple" infinitesimal geometry, which predictes, via numerical measures, the more complex behavior we observe. For example, what constitutes a "curve" from the new vewpoint of infinitesmial modeling is defined in the first calculus textbook. De l'Hospital (1715) uses the "infinitely small" terminology exclusively and utilizes a formal "definition - axiom" process supposedly delineating from the notion of "simple" infinitesimal behavior.

For de l'Hospital, a curve is an infinite collection of infinitely small line segments. The notion of the "curvature" is but the angle made by adjacent line segments. Indeed, he also describes a curve as being identifiably the same as a polygon with a fixed infinite number of line segments comprising its sides. On the other hand, Eudoxus [370 BC] devised the **method of exhaustion**, which assumes the existence of a finite sequence of inscribed and circumscribed polygons. In general, for a closed non-polygonal curve none of these Eudoxus polygons were considered to be the curve under investigation; but, rather, by the "continuity process" they would continually squeeze the curve between these two types of polygons and "exhaust" the space in between. By this process, the length of a curved segment was conceived of as an intuitive sequence composed of portions of the polygon perimeters. Thus developed the idea of a partial sum that represented the sum of the lengths of the sides of an n-gon - a finite sum that remained finite but acquired more and more terms. Those that employ this method often guess at a specific formula then justify their guess by indirect and not direct argument. Newton uses this type of arguement in his Mathematical Principles of Natural Philosophy.

After Newton, the language of the infinitesimals and infinitesimal geometric entities becomes the foundations of mathematical analysis and the calculus. Unfortunately, the languaue leads to a major contradition. A reading of Cauchy's Cours d'Analyse (Analyse Algébrique, 1821) yields the fact, even to the causal observer, that he relied heavily upon this amalgamation of terms and in numerous cases utilized infinitesimal reasoning entirely for his "rigorous" demonstrations. He claims to establish an important theorem using his methods - a theorem that Abel (1826) shows by a counterexample to be in error. No matter how mathematicians of that time period describe their vague infinitesimal methods they fail to produce the appropriately altered theorem - a modified theorem that is essential to many applied areas such as Fourier and Generalize Fourier Analysis. So, Cauchy introduced a new definition to rectify the situation. Later this terminology was replaced with the formal limit concept.

But, in the physical sciences, the use of this language continues. In his 1930's books on mechanics, Planck describes the accepted procedure for modeling the behavior of a physical-system when he writes that: *"a finite change in Nature always occurs in a finite time, and hence resolves into a series of infinitely small changes which occur in successive infinitely small intervals of time."* All of these difficuties are corrected by the methods of Robinson (1966) and we can now return to the highly intuitive concepts of infinitesimal analysis. (Keesler, 1986. Herrmann [B]) But, do infinitesimal measures depict physical reality or are all such concepts merely imaginary and a calculus based upon them is but the most outstanding example of an analog mathematical model? That is, it predicts physical behavior but it is based entirely on a simplified imaginary construct that neither physically exists nor measures aspects of any physical-system.

It is in 1961 that Robinson solves the three hundred year old problem of Leibniz and fines the correct algebraic properties for the infiniteimals. Distinct from the statements made by Leibniz, they do not act like the real numbers in all respects. They do form a subset of the hyperreal numbers, ${}^*\mathbb{R}$, and satisfy only "ring" properties. Technically, the infinitesimals, $\mu(0)$, form a maxium ideal in the ring of finite numbers, where the finite numbers also form a subset of the hyperreals. However, although the set ${}^*\mathbb{R}$ is an ordered field, it is missing an important real number property. For example, each positive hyperreal, which is not an infinitesimal, is an upper bound for the set $\mu(0)$, but $\mu(0)$ has no least upper bound. With respect to the use of the infinitesimals $\mu(0)$ or other members of the hyperreals ${}^*\mathbb{R}$ to measure quantities or properties Robinson makes the following observation.

> "For phenomena on a different scale, such as considered in Modern Physics, the dimensions of a particular body or process may not be observable directly. Accordingly the question whether or not a scale of non-standard analysis is appropriate to the physical world really amounts to asking whether or not such a system provides a better explanation of certain observable phenomena than the standard system of real numbers. The possibility that this is the case should be borne in mind." Fine Hall, Princeton University. (Robinson, l961)

Human beings using mental processes construct devices to measure, via numerical means, what they define as physical properties. These devices did not exist prior to their invention and construction. Except for these devices, Nature does not display any numerical quantities. Thus far in this section, with the exception of an observation of the motion of an observable object, all of the named entities are mental constructs used to predict observable behavior. Whether these correspond to “real” entities that are not observable is a philosophic stance. For the GGU-model, this is strongly the case. Although the systems produced by the GGU-model processes are independent from a specific cosmology, from everyday observation of physical behavior, the entities employed are predicted by the methods of nonstandard analysis. Indeed, the GGU-model into-fields are composed of gatherings of **propertons** and they are dependent upon the ultra-properton that is characterized by but two non-zero infinitesimal numbers. These entities produce each physical-system within a universe. But, if such entities exist, they are not physical entities within a universe but rather exist in a substratum world that contains a physical world.

3. Vector Fields and the Further Modeling of Observables and Unobserbables.

Newton actually is the one who thought of what we today call the “vector.” We can observe vector behavior in that we notice not merely motion but the relative direction of such motion. Newton models mathematically the combined result of two such vector motions via the diagonal of a parallelogram. Thus, one can first observe behavior, then linguistically describe such behavior, then mathematically model it. This is followed by returning to the linguistic description for an observation and this yields human mental impressions for those who comprehend the meanings of the terms employed. Certain processes take place within the brain of an individual. This is where an individual’s “thoughts” are composed and the linguistic description and mathematical model appear to originate. Nature does not provide these linguistic aspects.

Today, geometric vector fields and the vector calculus are a major tool for the prediction of physical behavior. Aristotle rejected the notion of there being any difference between a set of line segment points and the “direction” one might choice for generating such a collection. But, the elementary illustration of the directed line is the main stay of the physical application of the vector calculus. These predict the two notions, a numerical measure and a relative direction. Is there any doubt that this is but a mental device, enhanced by a **pictorial representation**, and beyond this directed line segments do not exist in physical reality?

Under specific circumstances, a physical “force” can be considered as producing observable effects. We invent various devices to measure forces. The concept of acceleration is also observable and can be described by the use of such a phase as “the speed (velocity as some state it) seems to be getting greater and greater.” But, just by watching such behavior does one obsevre a numerical relation between measures for these two notions? No. But, such a relation is obtainable via humanly constructed measuring devices.

Newton was very careful in differentiating between the physical concept and measures for the concept. This is not done today. First, Newton defines the "quantity of motion" as follows:

> "The quantity of motion is the measure of the same, arising from the [scalar] velocity and the quantity of matter conjointly." (Newton, 1686 (1934, (p. 1)))

Thus the quantity of motion is what we call **momentum**. One might ask, how or why did Newton even consider this notion since it is rather unobservable. As indicated by the explanation that follows his statement, his Second Law was **not derived** but rather is based upon an observation that

> "The [uniform] change of [the quantity of] motion is proportional to the [constant] motive force impressed; and is made in the direction of the right [i.e., straight] line in which the force is impressed." (Newton, 1686 (1934, (p. 13)))

In the standard elementary physics textbook, the Second Law, in differential form, is used to derive an expression that yields a symbolic expression that involves the first quantity, the measure of momentum.

Newton then proceeds in the Scholium to that section to apply this Second Law and his idea that the total effect of finitely many constant forces is additive over time to establish Galileo's discovery that the "...descent of bodies varies as the square of the time." (Newton, 1686 (1934, (p. 21))) In terms of a constant impulse notion, Newton's argument does not include the mass, but rather leaves the mass as the constant of proportionality. It has been stated that, due to its applications, his Second Law of Motion is the most significant physical law ever devised and it does relate to observables. It is a mathematical model for observable acceleration (uniform change) effects.

The mathematical model expressed as $F = ma = m(dv/dt)$ or in Newton notation $F = mv_t$ can predict relative behavior that is linguistically describable without actual measuring devices. Consider $F = K$ and $F_1 = Kt$. Then a little calculus yields $Kt = mv$, $(K/2)t^2 = mv_1$. (Today, these are usually written in vector form.) One object A moving with measured speed $Kt/m = v$ can be compared, in an approximate way via observation, with an object B moving "parallel" to A but with speed $(K/(2m))t^2 = v_1$ by stating that B appears to be accelerating (changing its speed) more rapidity than A. This observation and description can precede the actual calculation of these expressions. On the other hand, this observation is a type of verification that such interpreted mathematical expressions have merit. Man made measuring devices can further verify the mathematical expressions.

Kepler's Laws of Planetary motion are consider as major examples of empirical science. One views the planet Mars over a long time period and notices that it appears to block out members of the star background. So, assuming the star background is rather fixed, our experiences with our environment allows us to conclude that Mars is moving. This is considered an observable property. Numerical measures are taken as to its changing position and after years of effort Kepler states his Second Law of Motion and it is claimed to be a major "Physical (Natural) Law." *A line segment from the Sun to a planet, though changing in length, sweeps out equal areas in equal time.*

However, there does not exist a material line segment from the Sun to a planet, there does not exist a material region swept out, and there is no material time marks within Nature. These are mental and unobservable constructs that we associate with measures or measuring devices that we employ. Nature does not display such numerical mesures. Further, one of the major claimed physical laws is the "conservation of momentum." As expressed today it states: *The total (vector) momentum of a physical-system that is subject to only internal forces remains constant.* But, vector momentum cannot be observed. The vector momentum has an indivivual existence, at least in symbolic form, as do measures of area but neither is a physical object beyond its symbolic form.

A 1950 college dictionary defines a Physical Law as follows:

> A physical law is a sequence of events in nature or human activities that has been observed to occur with unvarying uniformity under the same conditions. Then this is followed by the formation, in words, of such a sequence.

(Of course, one might wonder how one shows that behavior "always" occurs in an unvarying uniform manner. Or is this just assumed to be the case after only a small finite number of observations?) Under this definition, the Conservation of Momentum and Kepler's Second Law are not physical laws. Indeed, today many entities listed as physical are not observable and any statement as to their behavior does not fit such a definition. These are mental constructs. Yet, such statements are claimed to be physical laws since we can use them to predict observed behavior that seems to verify our mental constructs. The evidence for the acceptance of any such physical law is said to be "indirect." However, there are distinctly different statements that yield, via human deduction, the same observed predictions. **Which statements one accepts as fact and, indeed, which unobservables one accepts as existing within a physical universe is a philosophic stance based upon other considerations.**

What is even more remarkable is that modern science is based upon human linguistics, invention and especially rational thought. How is it possible that but one species has developed these capacities and that our universe is so constructed that we can predict future behavior by application of these mental constructs? Much behavior within Nature corresponds to our mental activity. Indeed, Nature seems to behave more like a mind than anything else we know. What is the probability that we are the only species on earth that has "evolved" in this manner?

4. Quantum Physics.

One of the most significant examples of the uses of unobservables as assumed physical objects is the Standard Model of Particle Physics. It appears likely that this secular model will be the final model and any further refinements will be rejected due to the lack of any indirect evidence for the existence of such refinements. The language for this theory does not allow for any description for the composition of a **quantum field**. This unobservable object is a **primitive** and as such must simply be assumed to exist and to have a set of endowed properties, properties that will allow it to be mathematically modeled.

Attempts are made to make two basic properties more imaginable by use of the terms "ripples" or "vibrations." The basic need for such vibrations for this "something" is due to the basic notion of the **energy quanta** first introduced by Max Planck and for which he won the 1918 Noble Prize in Physics. Planck first considers the expression $E = h\nu$ as a purely symbol form that he uses in his expression for black-body radition as first presented in his published article (1900). But, to win such a prize, at that time, one would need to assume that it represents real physical behavior. The constant h has the units of joul-sec. In this specific case, electromegnetic energy occurs in a discrete form, where ν is a freqeuncy measure so that the energy measure has the proper unit of measure. The 1918 Nobel Prize in Physics was awarded to Max Planck for this specific idea and accepted physical "fact."

One not only endows such a thing with energy quanta but with momentum quanta as well via the expression $p = mc = (E/c^2)c = E/c = (h\nu)/c = h/\lambda$, where λ is the wave-length of the electromagnetic radiation. But, does it take a great deal of imagination to now generalize this quanta idea to other physical objects that have a mass measure? De Broglie did just that, for electrons, and simply changed c to v. He postulates the de Broglie wave length for such particles as $\lambda = h/p = h/(mv)$. One might even consider a de Broglie frequency. After all its just a change in how one expresses this result. And, of course, he won the Noble Prize in Physics for his "discovery" of the wave nature of electrons.

What is good for an electron is certainly good for all other particles with a mass number. Hence, from this one case, a complete generalization is made. Thus is born the unobservable general quantum field that ripples and displays particle properties. A true physical entity, we are told by the realist, that is not merely a mental construct used to calculate observed physical behavior. Then there are the "virtual" particles, such as virtual photons. They exist, of course, but are so elusive that . . . *they never really appear in the initial or final conditions of the experiment. . . .*(Feynman. 1985, (p. 95, Foot note 7)) There are the **positivists** who do not accept such fields as physically real. To them, quantum mechanics is but a mathematical tool to calculate behavior, which we cannot otherwise comprehend. We have the two opposite philosophic stances that arrive at the same predicted conclusions, where the realist community has a grandiose idea as to the creative inventiveness of its members.

5. Why Are There Contradictions and The Secular GGU-model Cosmogony.

As children we learn how to count and associate the symbols 1, 2, 3, 4, . . . with objects in a nonempty bag of apples. The symbols 1, 2, 3, 4, . . . represent members of the set of natural numbers, $\mathbb{N}$. Then we learn about the number 0 that symbolizes the number of objects in an empty bag and it is considered as a member of $\mathbb{N}$, (i.e. $0 \in \mathbb{N}$.) Then $\mathbb{N}$ is also accorded certain order properties. The set $\mathbb{N}$ and its properties can be assumed or such entities are constructed from collections of empty sets, when modern set-theory is applied. This same set-theory, with an added item, is used to the construct the GGU-model's mathematical structure.

The order $<$ is used to define a special collection of subsets of $\mathbb{N}$. Let $n \in \mathbb{N}$ and $n \geq 1$. Then define the **interval** $[1, n]$ as a subset of $\mathbb{N}$, where $x \in [1, n]$ if and only if $1 \leq x \leq n$. Mathematically, we then model our counting of a bag of 5 apples by considering a relation f, a function as it is termed among other names, that assigns to each member of the set $[1, 5]$ one and only one object from the bag so that all members of the bag of apples are assigned one of these number names. (Notice how precise this process has been defined.) Finally, we say that we have a *finite* bag of apples. So, one states that a set of entities is **finite** if such a function exists. We add to this by calling the empty set, a set that contains no members, finite. If such a function does not exist for a nonempty set C, then the set C is not finite, that is, it is infinite.

All the mathematical entities just named are called **standard** entities although a few individuals call them "classical." Indeed, all of the usual mathematical objects one learns about today can be classified as standard entities and each carries its standard name. Using the standard names, one learns that collections of finite sets have properties. For example, if A and B are two nonempty finite sets, then the combination $A \cup B$ is a finite set. Also the other basic set-theory operations $\cap$, and $-$ applied to finite sets yield finite sets.

But, what happens when such sets are formally defined and their properties are viewed from a special structure called a **nonstandard structue, an enlargement**?

(The term "nonstandard" is but a technical term.) A standard set such as A turns into the set ${}^*A$. The original standard set A has a copy in this structure, which has the same formal proprties as A. This is denoted by ${}^\sigma A$. (In certain cases the ${}^\sigma$ is dropped.) The entity ${}^*A$ is, in general, an **internal** set. (Some authors also call ${}^*A$ a standard (internal) set. I call it an extended standard set.) But why do we need this new percision of language?

The reason for this is that the "formal" properties of the finite hold for the transformed standard finite sets. Further, we can investigate and describe in terms of the meta-language of the set-theory, where all these things exist, relations between the standard behaving object ${}^\sigma A$ and the internal ${}^*A$. First, if A is finite, then ${}^\sigma A$ is finite and, indeed, ${}^\sigma A = {}^*A$ in this case. But, there are internal sets that formally behave like finite sets if only the terms for internal objects are used, where in the set-theory they are actually infinite. Consider the result that the natural numbers $\mathbb{N}$ transform into the set of "hypernatural" numbers ${}^*\mathbb{N}$ and ${}^\sigma\mathbb{N} \neq {}^*\mathbb{N}$, where, for technical reasons, it can be assumed that ${}^\sigma\mathbb{N} = \mathbb{N}$.

Taking internal λ in ${}^*\mathbb{N} - \mathbb{N}$, we have the internal hyper-interval $[0, \lambda] = \{x \mid (x \in {}^*\mathbb{N})$ and $(0 \leq x \leq \lambda)\}$. (Technically, one would write 0 as ^{*0} but, by convention, it is expressed as 0.) Formally, the language of the internal must be used and $[0, \lambda]$ behaves just like a <u>finite interval</u>, but $\mathbb{N} \subset [0, \lambda]$, when viewed in the meta-language. Thus, $[0, \lambda]$ is actually an infinite set. That is why we generally call such entities **hyperfinite** although some hyperfinite sets can be finite in the set-theoretic sense. Now $\mathbb{N}$ is considered as a member of the mathematical structure, but it is not an internal member so we call it an **external** member. This is why we must be more precise in the use of language. This additional language avoids the obvious contradiction that a set is both finite and infinite. The set of natural numbers $\mathbb{N}$ is a standard entity, but the hyperfinite interval $[0, \lambda]$ is a nonstandard internal entity.

Thus is born the notion of the hyperfinite. All hyperfinite sets are internal. The difference between the hyperfinite and finite, when viewed from the meta-langrage, can be rather unusual. If A is any infinite standard set, then its copy ${}^\sigma A$ is infinite. But, there exists a hyperfinite B such that ${}^\sigma A \subset B$. This indicates that to avoid contradictions the language must be precise and one needs to use such differentiating terms as "standard" and "internal" or it is necessary to understand that the entities are of these two types. But, they are not mutally exclusive. A nonempty finite ${}^\sigma A$ is also internal. (If one can follow this, then this is why. A nonempty finite set A has constant names assigned to its members, say a, b, c, d. Then the following formal statement holds in the standard superstructure, $\forall x(x \in A \in X_n \leftrightarrow ((x = a) \wedge (x = b) \wedge (x = c) \wedge (x = d)))$. One thinks of $\wedge$ as "and" to arrive at this from the informal statement. Then this transforms into the statement $\forall x(x \in {}^*A \in {}^*X_n \leftrightarrow ((x = {}^*a) \wedge (x = {}^*b) \wedge (x = {}^*c) \wedge (x = {}^*d)))$. Due to the location of ${}^*A$, it is internal.)

(There are actually two different "superstructures" employed, the standard one and the enlangement. If $a \in X$, where X is the basic underlying set from which the standard superstructure is constructed, then ${}^*a \in {}^*Y$, where Y is the basic set from which the enlargement is constructed. For these sets, due to the type of set-theory employed, by convention, each ${}^*a$ is denoted by a and one considers $X \subset Y$ at this level, at least, of the construction of the enlargment. (Loeb and Wolf, 2000, (p. 39))

One significant feature of all of this is that it is in the nonstandard structure that the infinitesimals $\mu(0)$ reside and the basic construction of the GGU-model leads directly to the hyperfinite. If you only communiate in the standard or internal language, then the set of infinitesimals cannot be discussed. However, each member and each finite subset of the infinitesimals is internal and can be discussed. The observed behavior modeled by the standard portion of the GGU-model is composed of finite behavior. The interpreted nonstandard portion is usually in terms of the hyperfinite, which when restricted to our physical world is but the finite case. Further, the hypernatural numbers ${}^*\mathbb{N}$ have the order $<$ that restricted to $\mathbb{N}$ is its usual order, but it does not satisfy an important property. The set of all infinite hypernaural numbers, $\mathbb{N}_\infty = {}^*\mathbb{N} - \mathbb{N}$, does not have a least (a first) member (i.e. ${}^*\mathbb{N}$ is not well-ordered). Further, these numbers model the infinitely large numbers of Newton and Leibniz.)

Electromagnetic radiation has a continuous energy spectrum. From this, by a special technique of coding or by a direct approach, the general paradigm method rationally predicts the statement "An elementary particle with total energy $c' + 1/(10^{\gamma'})$." The γ' is an infinite hyper-natural number. Let $c' = 0$ and denote γ' by ω. Hence, this predicts an infinitesimal energy value $1/10^\omega$. Theorem 11.1.1 ([C]) states that for any real number $r \neq 0$ there is an infinite hyper-natural number λ such that r is "infinitesimally near to" $\lambda/10^\omega$. This means that there is an infinitesimal ϵ such that $r = \lambda/10^\omega + \epsilon$. A human being can rather easily pick form one-hundred black balls on a pool table the only white ball present. This type of selection process is one property of the "standard part operator" $\mathtt{St}$. Applying this operator to $\lambda/10^\omega$ yields the unique r. Hence, following the generalization procedure previously described, $\pm$ this infinitesimal measure is accorded other numerically defined measures for physical properties. Using only $\pm 1/10^\omega$ as coordinates in n-tuple form with certain linear algebra properties, the substratum mathematical representation for the **ultra-properton** is obtained.

Consider the "energy" coordinate. A hyperfinite gathering of λ ultra-propertons yields the **intermediate properton** as follows: Using independent coordinate addition applied hyperfinitely many λ "times" (a hyperfinite process) to this ultra-properton yields an intermediate properton. This is an substratum entity or a mere intermediate step in the formation of a physical universe. For example, all the property measuring coordinates, except for the one say the energy, remain as $\pm 1/10^{\omega}$ while the energy coordinate is now $\lambda/10^{\omega}$. After application of `St`, this yields the non-infinitesimal physical measure r for the one physical property - energy. If a property is only generally describable, then this property also has a coordinate assigned and the intermediate properton is obtained by applying the model's coded representation for the general description. A properton is a mathematical representation.

> We differentiate physical objects from one-another by their properties. Intermediate propertons are gathered together, and then these gatherings are further gathered together. To produce a physical-system, this "gathering process" is continued until all entities that comprise the system are represented via properties - via these properton combinations. This gathering notion is modeled after the raw material gathering process employed to prepare for the construction of man made physical-systems.

Mathematics is based upon detailed and exact definitions and instructions. These must be commonly understood by a mathematics community. It is also based upon human physical notations such as to the "left, right, top, bottom, back, and front." Often, for a "simple" set of rules, the actual linguistic instructions are diagrammatically presented. In mathematically logic, one needs to express strings of symbols in a common exact "left-to-right" form. Such a form is (1) $\forall x \exists y(p(x) \land q(y) \to \forall z(q(z) \to P))$. (One often simplifies by removing some of the parentheses via the concept of strengths of connectives.) Why is this form considered as correct and (2) $\land \forall x(p(x) \exists y q(y) \to \forall z(q(z) \to P))$ is not acceptable? The way one does this for this type of symbol string is via its standard interpretation, which is a linguistic statement written from left-to-right.

The "sentence" (1) translates as "For each x, there exists a y such that if p(x) and q(y), then for each z, if q(z), then P." If one substitutes simply declarative statements for p(x)and q(y), like "x is a boy" "y is a girl" etc., then this can have a "truth value." Now (2) reads "And, for each x, if p(x) there exist y such that q(y), then for each z, if q(z), then P." One needs to know that in these forms $\land$ is a binary operation and requires an entity on the "left." Then considered the notion of the "free variable" in a symbol string of this type. All logicians need to agree as to what free variables are and where they are located within a collection of such strings of symbols or they cannot follow the explicit rule "substitute at each position where x is free the variable z." Of course, there are many, many other such explicit instructions and definitions given throughout mathematics.

There are certain instructions that, although describable, also have a diagrammatical definition. In an advanced textbook, an orientated lift-hand coordinate system is defined by a drawing of a left-hand, where the thumb and two figures are pointing in the appropriate relative directions.

Throughout all of physical science, explicit and commonly understood general descriptions, descriptions that are linguistic or diagrammatical in nature, are the major way to convey physical behavior. The most general aspect of the GGU-model is that it is, in the scalar case, an analogue modeled that directly yields a one-to-one relation between descriptions for physical-systems and the "actual" physical-systems depicted. Within our physical world, certain human and mental processes are first modeled. These mathematically symbolized entities are embedded within a mathematical structure and corresponding entities are predicted to exist within a substratum world. These lead to a small finite number of sequentially presented operators that represent substratum process. It is these operators that yield a physical universe.

A complete slice of a developing universe at a moment of observer time, a **universe wide frozen frame (UWFF)**, is considered as describable in detail and in relative terms via members of a general language $\mathbf{L}$. This is accomplished by describing its physical-systems in ever increasing complexity. But, the model predicts an additional feature.

> The mathematics predicts that there is another language ${}^*\mathbf{L}$ that contains $\mathbf{L}$ and, except in a few cases, we can have no knowledge as the members of ${}^*\mathbf{L}$ that are not members of $\mathbf{L}$ (members of ${}^*\mathbf{L} - \mathbf{L}$). Further, combinations of these unknown elements also have "meanings" that no biological entity within a universe can comprehend. These are termed as **hyper-meaningful** expressions.

Due to the hyper-meaningful expressions, we are not able to describe the universe producing GGU-model processes in great detail. Only general descriptions are possible. There are various mathematically presented schemes that are used to express these processes. Each is presented in two different patterns depending upon how one wishes to read the sequence. The symbolically least complex of these schemes is

$$\text{(M) } \mathtt{St}([\![({}^*\underline{\mathcal{A}}((\Gamma^{(q,r)}(x,\lambda), IF_\lambda^{(q,r)}(a,b))))]\!]) \Rightarrow \mathcal{U}. \tag{5.1}$$

A specific gathering, that is the properton combinations, for a UWFF is called an **info-field**. But, the actual gathering process is not assumed for this scenario. Only the info-fields are assumed to exist within the substratum. Although the GGU-model is a cosmogony and not dependent upon specific physical laws, the notion of general "physical-systems" is retained as is the concept of numerical measures OR general property descriptions. Only the collections of substratum info-fields need to exist for the model to produce a developing universe. Thus, for the substratum, they are not primitives in the sense of quantum fields since they are composed of combinations of primitive ultra-propertons. The symbols $IF_\lambda^{(q,r)}(a,b)$ denote such an info-field. And the symbols $\Gamma^{(q,r)}(x,\lambda)$ denote a special collection of info-fields that, in a sequential manner, produce a universe. But, assuming that within a secular substratum the mathematical notion of an ordered set of natural numbers has no meaning, how can such a sequence be achieved?

In order to obtain a sequential development, the set of info-fields $\Gamma^{(q,r)}(x,\lambda)$ is constructed in a special manner. Prior to embedding into our mathematical structure, the algorithm $\mathcal{A}$ is the basic **logic-system** algorithm for a specially modified logic-system. Upon embedding into the mathematical structure, the predicted algorithm is now applied to an "hyperfinite internal" object $\Gamma^{(q,r)}(x,\lambda)$.

The description for the standard algorithm $\mathcal{A}$ displays the most basic deductive process that is known as **modus ponens (the rule of detachment)**. But, for this special case, this logic-system algorithm can be simplified by presenting the logic-system in a special form. When this logic-system is embedded, the hyperfinite collection $\Gamma^{(q,r)}(x,\lambda)$ is predicted to exist. Then the predicted and characterizable algorithm ${}^*\underline{\mathcal{A}}$ is applied to $\Gamma^{(q,r)}(x,\lambda)$ and each info-field is presented in its proper sequential order. The symbols $\mathtt{St}([\![...]\!])$ signify the application of the standard part operator at each sequential step. This reveals each physical UWFF at each moment in observer time. A few more descriptive refinements yields the entire development of a universe. This approach applies even in the case a universe has no "beginning" or no "ending" or where each UWFF is of infinite content.

6. An Intermediate GGU-model Cosmogony.

In order to incorporate the gathering process, the notion of the **instruction paradigm** is adjoined to the scheme (5.1). In this case, there are two forms of the appropriate scheme.

$$(\mathtt{St}G_\lambda^{(q,r)})([\![(\ {}^*\underline{\mathcal{A}}(\ {}^*\mathbf{\Lambda}^{(q,r)}(x,\lambda),\{\ {}^*\mathbf{I}_{\nu,\gamma,\lambda}^{(q,r)}(b,c)\}))]\!]) \Rightarrow \mathcal{U}. \tag{6.1}$$

$$G_\lambda^{(q,r)}([\![(\ {}^*\underline{\mathcal{A}}(\ {}^*\mathbf{\Lambda}^{(q,r)}(x,\lambda),\{\ {}^*\mathbf{I}_{\nu,\gamma,\lambda}^{(q,r)}(b,c)\}))]\!]) = (\Gamma^{(q,r)}(x,\lambda), IF_\lambda^{(q,r)}(b,c)) \Rightarrow$$

$$\mathtt{St}([\![(\ {}^*\underline{\mathcal{A}}((\Gamma^{(q,r)}(x,\lambda), IF_\lambda^{(q,r)}(b,c)))]\!]) \Rightarrow \mathcal{U} \qquad (6.2).$$

The symbols with the * attached in the three schemes (5.1), (6.1), (6.2) all represent the predicted embedded objects [D]. The "instructions," such as ${}^*\mathbf{I}_{\nu,\gamma,\lambda}^{(q,r)}(b,c)$ where ${}^*\mathbf{I}$ is also denoted as ${}^*\mathbf{F}$, are considered as linguistically presented substratum laws.

The collection ${}^*\mathbf{\Lambda}^{(q,r)}(x,\lambda)$ of hyper-instructions has the same sequential generating form as $\Gamma^{(q,r)}(x,\lambda)$ and ${}^*\underline{\mathcal{A}}$ is the same algorithm as in the (5.1) case. $G^{(q,r)}_\lambda([\![...]\!])$ is the gathering operator that is guided by each sequentially produced member of ${}^*\mathbf{\Lambda}^{(q,r)}(x,\lambda)$ and yields the appropriate info-fields to which `St` is applied. Of course, the last expression in (6.2) is (M).

This scheme reveals an additional interpretation that corresponds to the non-secular case. However, this interpretation is not necessary at this stage. It refers to the linguistic nature of the instructions and that they are a predicted extension of the simple "counting" concept.

7. A Non-Secular GGU-model Interpretation.

Each of the schemes thus far presented has a non-secular interpretation in terms of General Intelligent Design (GID). Scheme (M) is the weakest of these. For GID, the operator ${}^*\underline{\mathcal{A}}$ is modeled after an embedded human deductive process. When mathematically characterized and compared to human deduction, it displays an "infinitely powerful" form of deduction. The operator `St` also displays a property that corresponds to a basic deduction scheme. Then for schemes (6.1) and (6.2), the instructions are actually hyper-instructions. This means they are written in terms of members of ${}^*\mathbf{L} - \mathbf{L}$. And, we can actually display some of these rules by adding a few symbols that represent the infinite numbers. We cannot add all the necessary symbols, however. Thus, these schemes can be interpreted as modeling certain higher-intelligence thoughts and thought processes. There is yet another scheme for the single-complexity universes that has a stronger GID interpretation. An additional scheme is used that is almost identical to a previous scheme.

$$\text{(S)}\ (\ {}^*\mathbf{\Lambda}^{(q,r)}(x,\lambda), \{\ {}^*\mathbf{f}^{(q,r)}_{\nu,\gamma,\lambda}(b,c)) \Rightarrow\ {}^*\underline{\mathcal{A}}[\![(\ {}^*\mathbf{\Lambda}^{(q,r)}(x,\lambda), \{\ {}^*\mathbf{f}^{(q,r)}_{\nu,\gamma,\lambda}(b,c)\})]\!] = d^q_a. \quad (7.1)$$

In this case, the ${}^*\mathbf{f}^{(q,r)}_{\nu,\gamma,\lambda}$ is an in-depth pre-designed description taken from ${}^*\mathbf{L}$ for a physical or physical-like "beginning" UWFF. This is the case even if a universe is without a physical beginning. The ${}^*\mathbf{\Lambda}^{(q,r)}(x,\lambda)$ is, as before, a specifically constructed collection of the pre-designed descriptions and ${}^*\underline{\mathcal{A}}$ is exactly same hyper-algorithm and sequential generates the pre-designed development, a developmental paradigm d^q_a. The instruction paradigm composed of members of the previous Λ set parallels this pre-designed developmental paradigm. This is a stronger GID scheme since it includes the per-design of a universe by a higher-intelligence.

There is yet another stronger scheme, the multi-complexity scheme found in [D] along with its additional higher-intelligence processes. All of these schemes yield rational models for creation of a universe by a higher-intelligence, and a general statement that "thoughts" are being changed into various realities. Given a particular UWFF $\mathbf{E}(j)$. Then, for the GGU-model, what we glean as physical laws do not change this UWFF into the next sequentially produced $\mathbf{E}(j+1)$. Yet, we describe such laws and predict future behavior. How is this possible? There is, at least, one answer to this question.

8. The Participator Model and a Solution.

A necessary and additional complexity is added to the GGU-model that selects specific members from a vast storehouse of pre-designed universes. These are the particular ones that correspond to alterations produced by our participation. [E] The thoughts of which we are aware are the products of physical-systems, which need to be a part of those systems that comprise our universe. Such thought patterns would consequently be pre-designed by a higher-intelligence if a scheme such as (7.1) is applied. Assuming this case, then one can conclude that what we claim are physical laws are actually pre-designed descriptions that will satisfy the sequential development of our universe. And, importantly, they allow us to predict future aspects of our universe's development. This also implies that many features of these laws can be but imaginary.

Since the GGU-model is a substratum model, it cannot be eliminated as a viable general alternative. As defined in [A], it is rather easy to show that when one adds the additional feature that the perceived physical laws are satisfied that the model is falsifiable. [F]

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