The Participator Model

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Abstract: In this article, the formal definition for the construction of the participator model is given. This is the major participator aspect for the generation of universes via GGU-model schemes. It is shown to be representable as a finite meet semi-lattice with lower unit.

1. Partially ordered sets.

Let P be a nonempty partially ordered set with order relation denoted by $\leq_P$. Such a set with its order is denoted by the ordered pair $(P, \leq_P)$. For $(P, \leq_P)$ and $a \in P$ define the **lower ideal**, $[a]{\downarrow}_P = \{x \mid (x \in P) \wedge (x \leq_P a)\}$.

Definition 2.1. (Compatible.) Let $\mathcal{A}$ be a nonempty set of partially ordered sets. The collection $\mathcal{A}$ is **compatible** if and only if for each $X, Y \in \mathcal{A}$ if $a \in X \cap Y$, then $[a]{\downarrow}_X = [a]{\downarrow}_Y$ and for each $x,\ y \in [a]{\downarrow}_X$, $(x, y) \in \leq_X$ if and only if $(x, y) \in \leq_Y$.

Definition 2.2. (Semi-lattices, lattices, chains.) For any partially ordered set X and $a,\ b \in X$, if the set $\{a, b\}$, has a greatest lower bound (g.l.b.) in X, then denote this as $a \wedge_X b$. A partially ordered set $(X, \leq_X)$, is a **meet semi-lattice** if and only if for each $a,\ b \in X,\ a \wedge b \in X$. A partially ordered set $(X, \leq_X)$ is a **join semi-lattice** if and only if for each $a,\ b \in X$, the set $\{a, b\}$ has a least upper bound $a \vee b \in X$. A partially ordered set $(X, \leq_X)$ is a **lattice** if and only if it is a meet and join semi-lattice. A partially ordered set $(X, \leq_X)$ is a **chain** if and only if for each $a,\ b \in X,\ a \leq_X b$ or $b \leq_X a$. For a chain, if $a,\ b \in X$ and $a \leq_X b$, then $a \wedge_X b = a$ and $a \vee_X b = b$. Hence, a chain is a lattice.

Definition 2.3. ($a \preceq b$.) Let $\mathcal{A}$ be a nonempty compatible set of partially ordered sets. For each $a,\ b \in \bigcup\{\mathcal{A}\}$, let $a \preceq b$ if and only if there exists an $X \in \mathcal{A}$ such that $a,\ b \in X$ and $a \leq_X b$. (This is well-defined for compatible sets. The notation $\preceq$ is also used as a representation for this relation as a set of ordered pairs.)

Theorem 2.1. *If $\mathcal{A}$ be a nonempty compatible set of partially ordered sets, then the relation $\preceq$ is a partial order.*

Proof. Let $a \in \bigcup\{\mathcal{A}\}$. The there is an $X \in \mathcal{A}$ such that $a \in X$. For this $X,\ a \leq_X a$. Hence, $a \preceq a$.

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Let $a,\ b, \in \bigcup \mathcal{A}$ and $a \preceq b$ and $b \preceq a$. Then there exists an $X \in \mathcal{A}$ such that $a,\ b \in X,\ a \leq_X b$ and there exists a $Y \in \mathcal{A}$ such that $a,\ b \in Y$ and $b \leq_Y a$. But via the compatible property, $[a]{\downarrow_X} = [a]{\downarrow_Y}$and, $b \in [a]{\downarrow_X}$. Thus $b \leq_X a$ implies, since $\leq_X$ is a partial order, that, for $\preceq$, $a = b$.

Let $a,\ b,\ c \in \bigcup \mathcal{A}$ and $a \preceq b,\ b \preceq c$. Then there exist $X,\ Y \in \mathcal{A}$ such that $a,\ b \in X$, and $b,\ c \in Y$ and $a \leq_X b,\ b \leq_Y c$. Again by compatibility, $[b]{\downarrow_X} = [b]{\downarrow_Y}$. Hence, $a \in Y$ and $a \leq_X b$ implies that $a \leq_Y b$.Thus, $a \leq_Y b,\ b \leq_Y c$ implies that $a \leq_Y c$. Consequently, $a \preceq c$ and the proof is complete.

2. Precise Predictions.

Does the language used for predictable physical science imply precision?

> "[C]onsider the process of alpha-particle emission in the radio-active decay of a nucleus, for example, of uranium. In a large aggregate of such nuclei, the precise time of decay of an individual nucleus fluctuates irregularly from one nucleus to another, but the *mean* decay time is predictable, and equal to about two thousand million years. Now consider any one of these individual nuclei, the decay of which can be detected by means of a Geiger counter. Whether this nucleus will decay tomorrow, next week, or in two thousand million years from now is something that the present quantum theory cannot predict." (Bohm, (1957,p. 88).

The rationality of quantum theory does not depend upon what can or cannot be predicted. The theory is rational relative to "how" it makes predictions. It does so via mathematics. The *interpretation* of the mathematics is external to this rationality. In the above quotation, the words "irregularly" and "cannot predict" refer to a problem with the language of quantum theory. The standard quantum physial language does not allow one to predict precisely how individual entities behave with respect to other language-element descriptions.

Bohm states, that other theories and, in particular his,

> "permit the representation of quantum-mechanical effects as arising out of an objectively real sub-stratum of continuous motion, existing at a lower level, and satisfying new laws which are such as to lead to those of the current quantum theory as approximations that are good only in what we shall call the quantum-mechanical level." (Bohm, (1957,p. 105).

For Bohm's theory, the absolute nature of the probability distribution is rejected. Of course, this statistical notion is based upon the requirement that the entities described using the language employed for Bohm's quantum-mechanical level do, in fact, individually behave in random manners. But, "somehow-or-other" large numbers do have a certain collective behavior. The philosophy of this science Bohm employs does allow one to give additional thought as to what "somehow-or-other" could actually produce this collective behavior. However, his notions do not eliminate "random" behavior.

Bohm considers an additional "sub-quantum" field, the "Schrödinger field," similar to but not part of the quantum-mechanical field theory, as described by the Schrödinger wave equation and the wave function ψ and the notion of a "quantum force" that, from a sub-quantum level, influenecs behavior at the quantum-mechanical level. He states,

> "In the quantum-mechanical problem, one can show by a treatment given elsewhere that with physically reasonably assumptions concerning the quantum force and the random motions coming from the sub-quantum mechanical level, we obtain Born's probability distribution $\mathrm{P} = |\psi|^2$." (Bohm, (1957, p. 114)

However, note that this does not eliminate the notion of imprecise "random motions" that occur on his sub-quantum level.

For the General Grand Unification Model (GGU-model), all of the statistical distributions, and, indeed, the probability-styled predictions used in quantum theory, are precisely predicted by pure ultralogic behavior (Herrmann, (2001)). The GGU-model is exactly that - a "general" model. The model predicts that there can be "ultranatural laws" that are satisifed by such pure ultralogic behavior. However, in this case, it is also predicted that, in general, there are no standard members of a general language L used by any entity within a universe that can predict the exact behavior detailed by the ultralogic.

As demonstrated in the next section, mathematicians use various physical processes that yield finite symbolic representations and accept these as legitimate methods to "prove" their theorems. The ultralogic satisfies this notion, but in place of the term "finite" the term "hyperfinite" is necessary. In this case, this is a type of finite that cannot be fully expressed using L. GGU-model mathematics is based upon modeling members of a general language L, which when embedded into the mathematical structure is denoted by $\mathbf{L}$. When further embedded into the nonstandard model used, another language ${}^*\mathbf{L}$, where $\mathbf{L} \subset {}^*\mathbf{L}$, is predicted to exist. Most members of ${}^*\mathbf{L}$ cannot be specifically "read." The model states that they have a form of meaning that is unknown to us. This is the major predicted "lack of knowledge" aspects. *The fact that this is predicted makes it a stronger statement than the accepted quantum theory linguistics barrier to further knowledge.* The individual predictions made by the these ultralogics are mostly described only by members of ${}^*\mathbf{L}$ that are not members of $\mathbf{L}$.

All of the previous GGU-model schemes and results, such as in Herrmann, (2013, 2013a, 2013b), should be consider as general schemes and results open to numerously many modifications and refinements that cannot be described using members of L. Some of the members of ${}^*\mathbf{L}$ have been expressed by adding symbols to L. This is how the "properton" is predicted. But, this is an unusual occurrence. In this article, due to this necessary lack of knowledge, the same lack of precision occurs since only general statements are made. As with quantum theory, this should not detract from the overall rationality presented.

3. Some Necessary Informal Mathematics.

Modern mathematical proofs rationally apply explicit or rationally implied rules for finite symbol manipulation. For thousands of years, visual diagrams, human physical as well as imagined processes have been used to "describe" either explicitly or by descriptive implication these "rules." In order to mathematically model a participator cosmogony, such rules are presented mostly via explicit descriptions.

One of the first such implied rules was expressed by Aristotle about 2,400 years ago. He wrote relative to human modes of deduction "For if X is predicated of any Y and Y is predicated of any Z, then it is necessary for X to be predicated of any Z." This is one of Aristotle's "figures" that many, many years later was presented in various simplified forms such as "A $\to$ B and B $\to$ C yields A $\to$ C," among others. The allowed procedures for such manipulation are learned often by simply "copying" what others have done or by convincingly presenting a new rule in order to obtain a new result.

The original Euclidean Geometry Axioms include statements such as *A geometric figure may be freely moved in space without any change in form or size. Geometric figures which can be made to coincide are congruent.* These are actually conceived of as physical processes. In the modern world, in Homology Algebra, diagrams are a major aspect of the entire subject. They are used to represent how one conceives of the application of chains of functions. Consider the diagram

$$\cdots \to A_{n+1} \xrightarrow{f_{n+1}} A_n \xrightarrow{f_n} A_{n-1} \to \cdots$$

that is used to define an exact sequence (Rotman, 1970, p. *viii*). Then more complex line diagrams and *diagram chasing* is used to prove Theorem 3.41 in Rotman (1970, p. 63).

In an induction proof, diagrams and the actual physical "removing" and "interchanging" of columns in a diagram are used to establish Theorem 5.2.1 in Wilder, (1952, p. 69). The function notation in this proof can be replaced with ordered pair notation and the proof restated. But, one needs to express the finite ordered pair notation as an intuitively ordered finite sequence. The geometric diagram Wilder uses is

$$\begin{array}{ccccc} 1 & 2 & & k & k+1 \\ \downarrow & \downarrow & \cdots\cdots & \downarrow & \downarrow \\ n_1 & n_2 & & n_k & n_{k+1} \end{array}.$$

Then this can be replaced with $(1, n_1),\ (2, n_2), \ldots, (k, n_k),\ (k+1, n_{k+1})$. However, one still needs the notion of removing and interchanging these symbolic forms in order to establish the theorem in the manner Wilder employs. It is all a matter of what is accepted by the mathematics community.

Generally, if one presents a nonempty "finite" collection of symbol strings or diagrams and defines or argues relative to these strings that such and such holds, then such definitions or arguments are accepted, respectively, at least for the finite case. These definitions or arguments are often stated in a manner that is not specific to the number of finite objects being considered. In such a case, they are assumed to hold for an arbitrary finite set. Then an *informal induction* method is also applied and its conclusions accepted. For definitions, informal induction is a description of how one "obtains" an object from a "previously" obtained object. The description need not be related to the natural numbers.

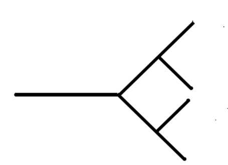
Informally, it is hardly ever mentioned, that a "choice" function is just as the name appears to state. Informally, it is a function obtained by some accepted form of "choosing." Jech (1973, p. 1) gives some examples of this. "Or, if all sets in $\mathcal{F}$ are *singletons*, i.e. sets of the form $\{a\}$, then one can easily find a choice function on $\mathcal{F}$." Notice that this is relative to our observing a special way of writing symbol-strings. Jech states that <u>any</u> finite collection $\mathcal{F}$ of nonempty sets has a choice function. He states "To show this, one uses induction on the size of $\mathcal{F}$; naturally, a choice function exists for a family which consists of a single nonempty set." In this "natural" case, the set could be 'infinite.' Even without considering such a process as an axiom, it is used to specifically identifying a "$b \in \{a\}$." However, such a symbolic selection as this is a viable logical process if one accepts the statement that "There exists an x such that . . . ." This is what "nonempty" means. Then the use of induction is rather informal. The last Jech statement describes informally things that can be done to each member of a finite collection of <u>various</u> nonempty sets via finite collections of such "$b \in A$" as informally defined strings of symbols. That is a finite form. If what is being finitely displayed is "clearly" understood, then the process is usually accepted for an arbitrary finite collection.

In Dugundji (1966, p. 224) is a proof that "For two topological spaces, the continuous image of a compact set is a compact set." In the proof we find (underlines added) "Then $\{f^{-1}(U_a)\}$ is a covering of Y and so <u>can be reduced</u> to a finite covering, $f^{-1}(U_{a_1}), \ldots, f^{-1}(U_{a_n})$. It is <u>evident</u> that $U_{a_1}, \ldots, U_{a_n}$ is a finite covering of $f(Y)$." I would have not used the phrase "and so can be reduced to" but would have written this as "and, hence, there exists," and then list the finite symbolic form "a finite. . . ." The term "evident" is not the only one used in such a case. The terms "clearly" and "obviously" are also employed for the process of "dropping" the f^{-1} notation or simply selecting the symbols $U_{a_1}, \ldots, U_{a_n}$. Indeed, I would not have used the term "evident" but rather have written "Hence, $U_{a_1}, \ldots, U_{a_n}$ is a finite covering of $f(Y)$." This is "clearly" a finite symbol manipulation that most mathematicians tend to accept.

In matrix theory, the meaning for the symbolic representations a_{ij} for the members of a matrix and procedures used to manipulate these finite collections of symbols are entirely motived by the notion of movement from the "left-to-right" in order to number the "column" locations and "top-down" in order to number the "row" locations. You cannot display such a geometric display without this intuitive understanding. Reading from top-to-bottom, the first symbol in the ij symbolism is a row number. Then moving from left-to-right, the second symbol (counting left-to-right) in the symbol-string ij is the column number. Without this rather human intuitive knowledge and physical abilities, you would not be able to display $a_{11},\ a_{1,2},\ a_{21},\ a_{22}$ as

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}.$$

From the standpoint of patterns, consider the following diagram.



Graph theory has established that any finite partially order set has a corresponding partially ordered set diagram such as the above (Abbott, (1969, p. 100)). However, this and similar diagrams that display a chain construction have an algebraic-like matrix-form as well. There will be four columns of branch-points that are contained in four rows. One observes that there appears to be four chains (polygonal paths, broken lines), which are to be matrix rows, containing three points (column locations) formed by the six line segments. There are three vertices and four end-points. These are the seven branch-points.

The original primitive sequences (previously termed as primitive time) used to obtain the various GGU-model schemes (Herrmann, (2013a)) are modeled by the ordered pairs (i, j) where $i \in \mathbf{Z}$, the set of integers, and $j \in \mathbb{N}$, the set of natural numbers including 0. The order impressed upon these ordered pairs is the lexicographic order that is similar to the order of a set of rational numbers. This is retained for a special simple order to be defined for the forthcoming chains. It is this diagram that motivates the following scheme for this simple case when one moves, generally, from left-to-right along the line segments.

Consider $a,\ b,\ a < b$. For (i, j), the j varies from 0 to $N \geq 1$. Let $N = 1$. Let each branch-point vertex have only $M = 2$ chain-creating line segments attached. A branch-point vertex starts at $(0, (a, 0))$. The top chain, row 1, begins with $(0, (a, 0))$. Moving right, column 2 branch-point vertex is denoted by $(1, 0, (a, 1))$. The branch-points are counted from left-to-right for a specific row. The next branch-point is the top chain end point $(1, 1, 0, (a + 1, 0))$. The ordering of this chain is defined by $(0, (a, 0)) \prec (1, 0, (a, 1)) \prec (1, 1, 0, (a + 1, 0))$. In all that follows, the term "tuple" is substituted for the usual "n-tuple." In all cases, equality only occurs under the definition for the equality of tuples. The next chains (rows 2, 3, 4) are $(0, (a, 0)) \prec (1, 0, (a, 1)) \prec (2, 1, 0, (a + 1, 0)); (0, (a, 0)) \prec (1, 0, (a, 1)) \prec (3, 2, 0, (a + 1, 0)); (0, (a, 0)) \prec (2, 0, (a, 1)) \prec (4, 2, 0, (a + 1, 0))$. Or as a matrix-styled rectangular array,

$$\begin{array}{ccccc}
(0,(a,0)) & \prec & (1,0,(a,1)) & \prec & (1,1,0,(a+1,0)) \\
(0,(a,0)) & \prec & (1,0,(a,1)) & \prec & (2,1,0,(a+1,0)) \\
(0,(a,0)) & \prec & (2,0,(a,1)) & \prec & (3,2,0,(a+1,0)) \\
(0,(a,0)) & \prec & (2,0,(a,1)) & \prec & (4,2,0,(a+1,0))
\end{array}.$$

Notice that, in each of the tuples, the non-ordered pair coordinate is a type of branch-point number. In column three, the number of repeated branch-point numbers tells us that only two branches are attached to each branch-point. Starting with the right most branch-point name and adjusting for the $(a+1, 0)$, as we drop the left most coordinate, we get the next left branch-point. Hence, if we are given the right end point identifier $(a, b, c, d, e, (a + 1, 0))$ and have available the basic primitive sequence employed, then the entire remaining chain of branch-points are obtained in descending order as $(b, c, d, (a, N)) \succ (c, d, (a, N - 1))$ etc. Now to construct additional chain points, continue the fixed number of constructed branches as $M = 2$. We apply the "repeated" collection rule and at the right end "jump" to the $(a + 1, 0)$ that is this primitive sequence interval end point. These rules allow us to now add a column of branch-points without using the diagram. The results in a matrix-styled array are

$$\begin{array}{ccccccc}
(0,(a,0)) & \prec & (1,0,(a,1)) & \prec & (1,1,0,(a,2)) & \prec & (1,1,1,0,(a+1,0)) \\
(0,(a,0)) & \prec & (1,0,(a,1)) & \prec & (1,1,0,(a,1)) & \prec & (2,1,1,0,(a+1,0)) \\
(0,(a,0)) & \prec & (1,0,(a,1)) & \prec & (2,1,0,(a,2)) & \prec & (3,2,1,0,(a+1,0)) \\
(0,(a,0)) & \prec & (1,0,(a,1)) & \prec & (2,1,0,(a,2)) & \prec & (4,2,1,0,(a+1,0)) \\
(0,(a,0)) & \prec & (2,0,(a,1)) & \prec & (3,2,0,(a,2)) & \prec & (5,3,2,0,(a+1,0)) \\
(0,(a,0)) & \prec & (2,0,(a,1)) & \prec & (3,2,0,(a,2)) & \prec & (6,3,2,0,(a+1,0)) \\
(0,(a,0)) & \prec & (2,0,(a,1)) & \prec & (4,2,0,(a,2)) & \prec & (7,4,2,0,(a+1,0)) \\
(0,(a,0)) & \prec & (2,0,(a,1)) & \prec & (4,2,0,(a,2)) & \prec & (8,4,2,0,(a+1,0))
\end{array}.$$

(Later a more complete and significant set of generation rules is presented.) In general, each of the tuples is considered a branch-point identifier. With respect to these identifiers, it is clear that each of these chains satisfies the requirements of Theorem 2.1. Hence, for the first and second full displays, we have a partially ordered set of identifiers. Further, it is also rather obvious that this forms a meet semi-lattice. In general for members $c,\ d$, a chain $c \wedge d = c$. For this case, for non-chain elements $(8,4,2,0,(a+1,0))$ and $(1,1,0,(a,1))$, simply take the two identifiers and consider the chains in which they are contained. Then reading from right-to-left, find the first branch-point number that both chains have in common. In this case, the $(0,(a,0))$. Thus $(8,4,2,0,(a+1,0)) \wedge (1,1,0,(a,1)) = (0,(a,0))$. Also, $(8,4,2,0,(a+1,0)) \wedge (2,1,0,(a,2)) = (0,(a,0))$.

Of further significance is that in these cases and, indeed, all the others to be considered, these meet semi-lattices have a "lower unit," $(0,(a,0))$, *(the left-most).* Also, for the actual construction of the original primitive sequence, each (i,j) corresponds to a rational number. It is sufficient to consider a fixed $K' \in \mathbb{N}'$, the set of natural numbers without the 0, and then each (i,j) corresponds to $(1/K')(i+1-1/2^j)$. The lexicographic order on the $\{(i,j)\}$ is order isomorphic to the rational number order for this set of rational numbers. *However, as well be further detailed, not all of the members of the primitive sequence intervals are members of these chains.* And the chain order $\prec$ is order isomorphic to the ordering of a finite set of rational numbers.

These rules allow us to add sixteen more branch-points to the matrix-styled array, where the first two columns of the display contain sixteen of the $(0,(a,0)) \prec$ and the remaining columns are fully displayed as

$$\begin{array}{ccccccc}
(1,0,(a,1)) & \prec & (1,1,0,(a,2)) & \prec & (1,1,1,0,(a,3)) & \prec & (1,1,1,1,0,(a+1,0)) \\
(1,0,(a,1)) & \prec & (1,1,0,(a,2)) & \prec & (1,1,1,0,(a,3)) & \prec & (2,1,1,1,0,(a+1,0)) \\
(1,0,(a,1)) & \prec & (1,1,0,(a,2)) & \prec & (2,1,1,0,(a,3)) & \prec & (3,2,1,1,0,(a+1,0)) \\
(1,0,(a,1)) & \prec & (1,1,0,(a,2)) & \prec & (2,1,1,0,(a,3)) & \prec & (4,2,1,1,0,(a+1,0)) \\
(1,0,(a,1)) & \prec & (2,1,0,(a,2)) & \prec & (3,2,1,0,(a,3)) & \prec & (5,3,2,1,0,(a+1,0)) \\
(1,0,(a,1)) & \prec & (2,1,0,(a,2)) & \prec & (3,2,1,0,(a,3)) & \prec & (6,3,2,1,0,(a+1,0)) \\
(1,0,(a,1)) & \prec & (2,1,0,(a,2)) & \prec & (4,2,1,0,(a,3)) & \prec & (7,4,2,1,0,(a+1,0)) \\
(1,0,(a,1)) & \prec & (2,1,0,(a,2)) & \prec & (4,2,1,0,(a,3)) & \prec & (8,4,2,1,0,(a+1,0))
\end{array}$$

$$
\begin{array}{ccccccc}
(2,0,(a,1)) & \prec & (3,2,0,(a,2)) & \prec & (5,3,2,0,(a,3)) & \prec & (9,5,3,2,0,(a+1,0)) \\
(2,0,(a,1)) & \prec & (3,2,0,(a,2)) & \prec & (5,3,2,0,(a,3)) & \prec & (10,5,3,2,0,(a+1,0)) \\
(2,0,(a,1)) & \prec & (3,2,0,(a,2)) & \prec & (6,3,2,0,(a,3)) & \prec & (11,6,3,2,0,(a+1,0)) \\
(2,0,(a,1)) & \prec & (3,2,0,(a,2)) & \prec & (6,3,2,0,(a,3)) & \prec & (12,6,3,2,0,(a+1,0)) \\
(2,0,(a,1)) & \prec & (4,2,0,(a,2)) & \prec & (7,4,2,0,(a,3)) & \prec & (13,7,4,2,0,(a+1,0)) \\
(2,0,(a,1)) & \prec & (4,2,0,(a,2)) & \prec & (7,4,2,0,(a,3)) & \prec & (14,7,4,2,0,(a+1,0)) \\
(2,0,(a,1)) & \prec & (4,2,0,(a,2)) & \prec & (8,4,2,0,(a,3)) & \prec & (15,8,4,2,0,(a+1,0)) \\
(2,0,(a,1)) & \prec & (4,2,0,(0,2)) & \prec & (8,4,2,0,(a,3)) & \prec & (16,8,4,2,0,(a+1,0))
\end{array}.
$$

And these identify the sixteen chains. Notice that the last coordinate in the last column's tuple representation is $(a+1,0)$. The rule for finding the greatest lower bound for any two branch-points in these arrays does not change. This indicates that the portion of the original primitive sequence here employed, with its lexicographic order, is identified as $(a,0) < (a,1) < (a,2) < (a,3) < (a{+}1,0)$. This is for a $3 = N \in \mathbb{N}$ case, where for only finitely many j we have $0 \leq j \leq 3$.

For the GGU-model, there is, in general, a "beginning slice of a universe" identified by $(\alpha, 0)$ and an "ending slice of a universe" identified by $(\beta, 0)$, where the values $\alpha,\ \beta$ depend upon the universe being modeled via nonstandard analysis. The participator model is based upon choices made by a maximum number of "biological" entities within our material universe. (For some modern cosmologies, our universe may be but one of many others.)

> These arrays, the chains and the meet semi-lattice formed, do not represent all of the points in the development. They represent only a fixed finite collection of such specially construction alterations. For this configuration and the GGU-model, four numbers $a,\ b = a+1, M, N$ determine this "superimposed" finite meet semi-lattice with lower unit.

Notice that at a given point in the construction, that for a given branch-point $(a_1, a_2, \ldots, a_k, (c,d)),\ k = N{+}2$, with natural number $k \geq 3$, the inductive constructed step-number, determines the total number of chains acquired when one more level of construction is adjoined. Then after such a construction, each descending (vertex produced) chain branch-point coordinate and its form is obtained by removing, in order, the a_1, then the $a_2,\ a_3$, etc. coordinates. For $a,\ a+1 \in \mathbf{Z}$ and $M,\ N \in \mathbb{N}$, and a specific chain, the number of branch-points (matrix-columns) is $p = N+2$. The total number of chains (matrix-rows) is M^{N+1}.

It is significant that, in this case, from the knowledge of the tuple used for the largest row and column number position and a rule for coordinate repetition the entire branch-point identifying array is predictable. For the $M,\ N \in \mathbb{N}$, where in all that follows $M \geq 2,\ N \geq 1$ (i.e. $N \in \mathbb{N}'$), then $k = N+2$ is calculated. The starting branch-point tuple is $(M^{N+1}, M^N, \ldots, M, 0, (a+1,0))$. For example, let $M = 3,\ k =$

2, $a+1=1$. Then this branch-point is $(9,3,0,(1,0))$. To generate the 8 other branch-point identifiers in this column, consider the coordinate numbers as if they appear in separate columns. This allows for the rule of "repetition" and reduction in the coordinate number value to be more easily applied.

> Given $(M^{N+1}, M^N, \ldots, M, 0, (a+1,0))$. For fixed M, the general rule is as follows: the number of repetitions of a specific number in coordinate position a_1 is M^0; in position coordinate a_2 is M^2; . . . ; and in coordinate positions a_k and a_{k+1} are M^{N+1} repetitions. For the a_k coordinate, all tuple values are 0 and, for the a_{k+1}, all coordinate values are $(a+1,0)$. The number of branch-points (chain members) is $k = N+2$. If more than one collection of repetitions exists, then the values of these repeated collections, as one moves from bottom-to-top, is the number used in the previous collection - 1.

Notationally, consider this as

$$\left\{\begin{array}{lcccccc} \text{Master tuple} & (M^{N+1}, & M^N, & M^{N-1}, & \cdots & 0, & (a+1,0)) \\ \text{Number repeated} & M^0 & M^1 & M^2 & \cdots & M^{N+1} & M^{N+1} \end{array}\right\}$$

with the appropriate subtraction. The following array is constructed from the bottom-to-top using information from this displayed scheme.

$$\begin{array}{cccc} (a_1 & a_2 & a_3 & a_4) \\ (1, & 1, & 0, & (a+1,0)) \\ (2, & 1, & 0, & (a+1,0)) \\ (3, & 1, & 0, & (a+1,0)) \\ (4, & 2, & 0, & (a+1,0)) \\ (5, & 2, & 0, & (a+1,0)) \\ (6, & 2, & 0, & (a+1,0)) \\ (7, & 3, & 0, & (a+1,0)) \\ (8, & 3, & 0, & (a+1,0) \\ (9, & 3, & 0, & (a+1,0)) \\ (3^2 & 3^1 & 0 & (a+1,0)) \\ 3^0 & 3^1 & 3^2 & 3^2 \end{array}$$

From this, the identifiers in each chain can be calculated by the "dropping of a coordinate rule" coupled with reducing the (c,d) values as required by the original sequence and, hence, these actual tuples yield a meet semi-lattice with a lower unit. For example, using the matrix column immediately above, where $M=3$ and $N=1$, a chain is $(0,(a,0)) \prec (2,0,(0,1)) \prec (6,2,0,(a+1,0))$.

Thus, for

$$\left\{\begin{array}{ccccc} (3^3, & 3^2, & 3^1, & 0, & (a+1,0)) \\ 3^0 & 3^1 & 3^2 & 3^3 & 3^3 \end{array}\right\},$$

the instructions yield the 27 chains and their numerical identifiers that comprise the meet semi-lattice with its lower bound $(0, (a, 0))$ determined by $M = 3,\ N = 2$.

Thus, in general, relative to the original single row scheme, the tuple $(a, a+1, M, N)$ and the previously described rules characterize the resulting meet semi-lattice.

These rules for determining the identifying tuples are highly relative to human observation and human experience relative to word meanings. Although such rules may be more formally expressed this is hardly ever done unless the results are considered of extreme significance. The method used to obtain the relations that represent the famous recursive relations Gödel used to model the informal rules for the construction of a formal "proof" in "Proof Theory" are formalizable in a first order predict language (Mendelson, (1987, pp. 150-154)). But, one must intuitively accept that the formal expression does, indeed, correspond to the informal description.

For another example of where human beings are used to define intuitively a mathematical notion, consider the idea of the left-handed δ-paving. For comprehension, Stroyan and Luxemburg (1976, p. 112) insert a drawing of a human left-hand showing the thumb and next two fingers pointing in the appropriate directions.

The above diagram only displays $M = 2,\ N = 1$. Obviously, from the matrix-form or the simple geometry, a similar finite diagram can be constructed for other $M \geq 2,\ N \geq 1$. From the geometric viewpoint, to each of the displayed diagram's line segment end-points, the exact same diagram can be attached. This yields a diagram for the interval $[a, a + 2]$. This corresponds to a second matrix-form that corresponds to each of the points to which the original geometric form is attached.

By line segment tracing, the line segment end-points and vertices as individual points form chains. All but one chain member is a vertex along a constructed and identifiable line segment polygonal path. Relative to these polygonal paths, since the added polygonal paths are attached to the previous paths, the entire attached line segments yields a set of compatible chains and a corresponding partially ordered set. Any two points in any of the last attached diagrams has a g.l.b within the attached diagram. If one of the points is not within the same attached diagram but a different attached diagram or within a previously constructed diagram, then both points have a g.l.b, which via diagram tracing is the "first" common identified polygonal path vertex within a previous construction. Hence, **the entire partially order set is a meet semi-lattice with lower unit**.

4. The Standard Participator Universe.

> It is difficult to believe that we can uncover this pregeometry except as we come to understand at the same time the necessity of the quantum

principle, with its "observer-participator," in the construction of the world (Patton and Wheeler, (1975, p. 575)).

The quantum principle throws out the old concept that of "observer" and replaces it with the concept of the "participator." It demolishes the concept that the universe "sits" out there (p. 563).

The idea is that as we make specific physical choices not only does our local environment change from what it would have been if we had not made the specific choice, but even the exterior portions of our universe can be influenced in various ways. This is a major requirement for an acceptable solution to the General Grand Unification problem, the problem of describing a cosmogony so that as a universe develops such choices produce an altered universe that then continues developing in concert with the alteration.

In Herrmann (2002), a DVD illustration for such a cosmogony is given. In Herrmann (2013b), a single level process is described via the generating ultra-logic-system and one of the GGU-model schemes. However, as yet, the most general approach is not described relative to the basic developmental and instruction paradigms. Applying a general approach as demonstrated in Section 3, other paradigms such as that employing only info-fields can be easily defined.

In order to more fully describe the participator model, the originally defined characteristics for members of a paradigm are altered to accommodate participator choices. *The above meet semi-lattice formed from constructed chains represents how the finitely many paradigms are constructed for the participator model.* However, this is a general statement. Each such designed universe-wide frozen-frame (UWFF) is relative not just to one individual's choice but the allowed choices, at least, for all of humanity; for the entire collection that exists at a particular moment in observer time. In Herrmann (2013b), a general method for constructing each UWFF is given. How this method is to be modified to present the physical-systems that comprise each individual member of this collection so that all the appropriate choices are rationally consistent with one another and yet satisfy the known physical laws is unknown. Most likely any such description forms a subset of the ${}^*\mathbf{L} - \mathbf{L}$ (the members of ${}^*\mathbf{L}$ that are not members of $\mathbf{L}$).

For the four types of universes viewed as generated over a finite portion of a primitive sequence, certain parameters are employed. In this finite case, there is an $a,\ b \in \mathbf{Z}$ such that $a \leq 0,\ b > 0$ and $a \leq i \leq b$. The value a identifies the "beginning" and the "b" the end of a finite period of event development. And this identifies the range of the i in the basic (generalized) sequence $\{(i,j)\}$. Then there is an $N \in \mathbb{N}'$ such that $0 \leq j \leq N,\ j \in \mathbb{N}$ and j is used for finitely many members of the intervals that comprise $[a, b]$.

A fourth parameter is the number $M \in \mathbb{N},\ M \geq 2$, of branch-points constructed from each previously obtained or defined end branch-point. There is a k such that $2 \leq k \in \mathbb{N}$ and the k measures the number of branch-points in the chains that form the attached meet semi-lattice. Further, $k = N + 2$ and is, hence, dependent upon N. In the matrix form, the number of columns is also k, while in coordinate form the number of coordinates is $k + 1$. By use of general induction as implied by the two illustrations for the construction of chains and the corresponding meet semi-lattice produced by application of Theorem 2.1, the entire finite collection of chains is obtainable. These chains form a finite standard portion of the standard paradigms.

For the GGU-model primitive sequence, the tuple concept has more than one but equivalent definition. For this article, the following definition is applied. For any sets $a,\ b$, the set (the form) $\{\{a\}, \{a, b\}\} = (a, b)$ is an "ordered pair." The singleton sets $\{a\}$ and doubleton sets $\{a, b\}$ have formal definitions, which are almost never presented. Their equivalent to counting the number of members of a set, which is what is intuitively done. It is the definition that models the intuition. Then there is a partial function $g\colon [1, n] \to X$, where $n \geq 2,\ n \in \mathbb{N},\ X \neq \emptyset$, where the set $\{(1, a), \ldots, (n, x)\} = (x_1, x_2, \ldots, x_k),\ x_1, \ldots, x_n \in X,\ a = x_1, \ldots, x = x_k$ is a tuple (i.e. n-tuple). The basic property for tuples depends upon our ability to find and read what are the members of a symbolic form. In order to have "form" knowledge as to what $(a, b) = (c, d)$ means, under what conditions is $A = \{\{a\}, \{a, b\}\} = \{\{c\}, \{c, d\}\} = B$?

We state that $(a, b) = (c, d)$ if and only if $a = c$ and $b = d$. Of course, $=$ means set equality. So let sets $a = c$ and $b = d$. By the law of substitution of equal sets $\{\{a\}, \{a, b\}\} = \{\{c\}, \{c, d\}\} = A = B$. (Of course, these are but finite sets of symbols and rules for manipulating these symbols are being applied.) Conversely, let the (intuitively) finite sets $\{\{a\}, \{a, b\}\} = \{\{c\}, \{c, d\}\}$. Then (by finite choice), let $x = \{a\}$. Then let $y \in \{a\}$. By choice again, $y = a$. By the definition of such a set (it has but one member intuitively) there does not exist any other distinct y that is a member of $\{a\}$. Now, in this case, $\{a\} \in \{\{c\}, \{c, d\}\}$. Let $c \neq d$. Then "clearly" (or maybe prove it), $\{a\} = \{c\}$. And this implies that $a = c$. If $c = d$, then $\{c, d\} = \{c\}$ and we again have that $a = c$. Then, as they often write, it follows easily that $\{a, b\} = \{c, d\}$. But, this is not really necessary since the definitions are actually obtained from the intuitive notations of how the symbolic forms behave, where one symbol is just a representation for another. Thus, the tuple concept can be expressed in the necessary formal form.

The systematic arrangement of a matrix illustration for any but the first diagram is tedious and unnecessary since the GGU-model allows for geometric instructions via the modeled language. Since only a finite number of required participator alterations need to be made and there are many more primitive sequence intervals than one, then only the geometric polygonal path concept is considered.

> For the GGU-model, the simple order for each path in the fixed meet semi-lattice is isomorphic to a fixed finite $R'_q \subset R_q$ of rational numbers and once the path is identified the rational number order on R'_q sufficiently characterizes the ordered behavior of the chain (path) members.

For each of the four types of universe generations, $q = 1,\ 2,\ 3,\ 4$, the function $\mathbf{f}^q$ is originally defined on $\mathbf{Z}_q \times \mathbb{N}$, by composition, where $\mathbf{Z}_q \subset \mathbf{Z}$. As mentioned, this is later refined and extended in such a manner that, for (i,j), each universe-wide frozen-frame ((i,j)-UWFF) is generated via the notion of physical-systems. For this application, this additional extension is not required. Each chain (path) is identified in what follows by the notation $P_n,\ n \in \mathbb{N}$. Then there is a finite collection of such $\mathbf{f}^q$ that generates each member of all of the participator model paradigms.

From the original concept of the general sequence t^q produced rational numbers, the paradigm members of the embedded developmental paradigm $\mathbf{d}_q$ [resp. instruction paradigm $\underline{\mathcal{I}}_q$] are defined by $\mathbf{f}^q$ on each such chain as a member of the general language $\mathbf{L}$.

> But, the paradigms are constructed in a <u>special manner</u> so that as different allowed paradigm members are added to each path P_n no previous paradigm path-member is altered. The standard paradigm continues until the next allowed choice alteration. Relative to the geometry this aspect is accomplished by simply considering additional paradigm points "between" each "branch-point."

Originally, for a single generating $\mathbf{f}^q$, each paradigm member of $\mathbf{L}$ used to describe a UWFF always contains the symbolic form (i,j) that differentiates one UWFF from the another. For this approach, the P_n path-related $\mathbf{f}^q$ are denoted by $\mathbf{f}^q_{P_n}$.

5. The Participator Model.

Nonstandard analysis, as is the case with much mathematics, is done via informal set-theory, where the sets are informally defined. This leads to the needed more formal statements. Further, today, actually using the famous *-transfer procedure is not often done but rather application of the monomorphism mapping * is employed. When all of the above is technically embedded into the nonstandard model, the above construction remains a standard part of the model and a finite collection, $\mathcal{F}^q$, of path-related $\mathbf{f}^q$ exists. Thus, ${}^*\mathbf{f}^q_{P_n} \in \mathcal{F}$ generates the appropriate UWFF in the exact manner as done in Herrmann (2013, 2013a), where ${}^*\mathbf{f}^q_{P_n}|P_n = \mathbf{f}^q_{P_n}|P_n$. This yields a standard embedded portion of the *paradigms that necessary influences the other members. The rules for the geometric form are also present within the model since they are embedded members of $\mathbf{L} \subset {}^*\mathbf{L}$.

> Hence, when restricted to the fixed R'_q, the range of each member of the finite set $\mathcal{F}^q$ corresponds to a finite chain of standard members of a *paradigm. This collection of chains forms a finite meet semi-lattice with lower unit that is superimposed over the entire collection of *paradigms.

Since 2002, it has been shown that the basic aspects of the GGU-model are nonstandard extensions of observable behavior. The standard finite meet semi-lattices describe in Section 3 are observed millions of times a day. Simply rotate by 90-degrees and in the positive direction the line segment figure previously presented. This and all of the other usable types correspond to many species of leafless trees viewed from the point where the first branch intersects the trunk.

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