AN INTRODUCTION TO MATHEMATICAL METAPHYSICS

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ABSTRACT: Since the time of Aristotle, metaphysics has been an ill-defined term. This paper defines it as a logically idempotent metalinguistic identity of reality which couples the two initial ingredients of awareness: perceptual reality (the basis of physics), and cognitive-perceptual syntax, a formalization of mind. The explanation has been reduced to a few very simple, clearly explained mathematical ingredients. This paper contains no assumptions or arguable assertions, and is therefore presented as an advanced formulation of logic which has been updated for meaningful reference to the structure of reality at large. This structure, called the Cognitive-Theoretic Model of the Universe or CTMU, resolves the problems attending Cartesian dualism by replacing dualism with the mathematical property of self-duality, meaning (for reality-theoretic purposes) the quantum-level invariance of identity under permutation of objective and spatiotemporal data types. The CTMU takes the form of a global coupling or superposition of mind and physical reality in a self-dual metaphysical identity M:L←→U, which can be intrinsically developed into a logico-geometrically self-dual, ontologically self- contained language incorporating its own medium of existence and comprising its own model therein.

Keywords: Metaphysics; Mathematics; Mathematical Metaphysics

INTRODUCTION

In these early years of the new millennium, there has been considerable academic concern over the stubbornness of Cartesian dualism and the conceptual difficulty of uniting the mental and physical sides of reality. Meanwhile, it has gone all but unnoticed in academic circles that the formal aspect of this challenge was met decades

ago, and in the most effective possible way. This paper contains a brief introductory account of the work in question, including a highly simplified description of the logicomathematical reasoning needed for the proper high-level theoretical description of reality. Everything follows from the requirements of this objective.

Aside from the author's own writings, there is as yet no well-defined field of mathematical metaphysics. Being an explanation of the author's previous work, this paper is largely an exercise in self-reference. The same applies to its bibliography. Conveniently enough, this is well in accord with a major theme herein emphasized, namely, the self-referential nature of reality.

THE NECESSITY OF METAPHYSICS

Whether or not any given scientist or philosopher of science chooses to admit it, science is heavily invested in the idea that there exists a valid, comprehensive theory of reality or "theory of everything" (ToE), and indeed there must. For reality as a whole has structure and history, and in principle, that structure and history are isomorphic to a valid comprehensive theory of reality that can be written in a language of sufficient expressive power, the existence of which would seem to be implied by the fact that reality is accessible to the mind and senses. In a pinch, one need merely wave expansively at the universe and declare that the theory shares its structure.

Unfortunately, getting any farther than this entails a few difficulties. For example, we must decide how reality should be studied in order to discover its structure, and by whom. A closely related issue, which we encounter before even getting around to establishing a valid correspondence between theory and content, is how to identify a language of sufficient expressive power to contain a valid, comprehensive description of reality.

If there were a scientific consensus on these issues, it might well go something like this:

> "Reality should be studied by physical scientists using the tools and methods of the physical sciences, and there can be no better language for expressing their findings than the language of physics. For after all, physics is the most fundamental science, that to which all other sciences can supposedly be reduced."

But this gives rise to yet another problem: physics is not self-explanatory. If physics is regarded as an expression of the structure of reality, then clearly it is real, and a comprehensive theory of reality must explain its every part and aspect. But then in order to qualify as a comprehensive theory of reality, physics must explain itself, its correspondence to reality, and arguably the biological origins and mental activity of physicists in whose minds it exists. In fact, physics as we know it can explain none of these things, or even the natural law of which it supposedly consists. Such explanations

are prohibited by its methodology as encoded in the scientific method, according to which it must constantly be tested by observation and experimentation.

Technically, it is not permitted to depart from the world of the senses.

As a matter of logic, the task of explaining such things as physics, the possibility of physics, and the relationship of physics to the physical universe requires a metalanguage of physics, a higher-order language in which the "object language" of physics can be an object of reference. Let a metalanguage capable of these functions be called "metaphysical". In order to properly refer to its content, the required metaphysical metalanguage must include physics, understood as the theoretical aggregate of physical insight, as a sublanguage, along with distinctions and classifiers suitable for distinguishing between reality and its complement or negation.

Moreover, because its metaphysical content must be mapped into reality along with its physical sublanguage, it must describe reality in such a way that it contains the codomain of this mapping, thereby establishing that reality has a metaphysical aspect.

Because it contains physics as a sublanguage, and physics is largely mathematical, the required metaphysical metalanguage must be mathematical as well. But ToE mathematical structure must be mathematics of a higher order, literally embedding and distributing over the mathematical structures employed in standard physics ... as does the language of mathematical logic in particular.

RELATIONAL STRUCTURE

The relational level of mathematical structure is always of crucial importance, especially with regard to connectivity and coherence.

Historically, the coherence and connectivity of reality have been impaired by dualism. The parallel distinctions between mind and matter, form and content, attribute and argument, property and substance, language and universe, and so on are conventionally understood as dualistic, positing a fundamental dissimilarity or separation between two entities whose separation is problematical. This can often be addressed by mapping the dualistic distinction to discernible but coincidental aspects of a single coherent entity, thereby making it a duality and therefore dualic. A similar metadistinction exists for a three-way distinction such as that between space, time, and object (or matter); it can be regarded as either trialistic or trialic.

Science proceeds by formal cognitive abstraction of perceptual content, for which it requires just two initial ingredients: perceptual reality (our perceptual relationship with the world of percepts or observable states), and the cognitive apparatus through which perceptual content, as well as the perceptual relationship between percept and percipient, is recognized and processed. Indeed, science can be regarded as the coupling of these two ingredients, and insmuch as the ingredients are coupled, as an

initial ingredient in its own right (later on, we'll be calling it "M"). Hence, the above dualisms and their remedial dualities bear heavily on scientific epistemology.

The cognitive and perceptual ingredients of reality have structure, and like all relationships, their relationship has structure as well. This structure is that of a syndiffeonic relation.

SYNDIFFEONESIS, THE RELATIONAL STRUCTURE OF REALITY

Any relationship of scientific interest is recognizable as a relationship and therefore intelligible, and every intelligible relationship involves the attribution of a property to its instances; i.e., the relationship is attributed to the things related by it. Other ways of saying this are that every intelligible relationship is a syndiffeonic relationship, or equivalently, that syndiffeonesis, the definitive property of syndiffeonic relationships, is the universal relational structure of reality as it is knowable to science.

Syndiffeonesis can be intuitively understood as "difference in sameness"; it is what occurs when an observer simultaneously recognizes any set of discernible objects in juxtaposition to their logical complements, or when a thinker simultaneously recognizes a set of concepts or values as similar or congruent. It captures the relational structure of attribution and the conceptual aggregation of discernibles, describing the situation in which a set of discernible instances is recognized or defined through a common syntax through which they are aggregated. Syntax consists of structural and dynamical invariants which support and constrain a language on all formal scales; they are distributed over the language intrinsically or by language-users. The concept can be generalized to any attribute or structure shared by a set of instances to be identified through it. Accepting syntax is that part or aspect of the mechanical structure or programming of a computational automaton which enables it to accept or "recognize" input; the concept can be generalized to non-mechanistic transduction.

Syndiffeonesis breaks down into sameness or synesis, which is stratified by order of relation or attribute, and difference or diffeonesis, which is a differentiative function of arity or cardinality. Every relationship, even a unary or nullary relationship, has two levels, synetic and diffeonic, with the synetic level consisting of common attributes or accepting-syntactic invariants, and the diffeonic level consisting of some number of discernible instances thereof (this number being the arity of the relationship). The generic syndiffeonic relation is "self- dual" in the sense that its synetic and diffeonic levels are dual to each other; they are respectively associated with orthogonal axes, the synetic ordinal axis and the diffeonic arity axis.

A syndiffeonic relation can be expressed in a number of ways, one of which is

$$s(d_1, d_2, d_3,...)$$

The diffeonic extension of the relation, being just a set of things that are simultaneously recognized as different instances of the property or syntax s which describes them, is inside the parentheses; the synetic intension which describes or distributes over the extension is to the left. This notation is designed to resemble an arithmetical expression like $n(a_1 + a_2 + a_3 + ...) = na_1 + na_2 + na_3 + ...$, in which multiplication distributes over addition. The di inside the parentheses are the "diffeonic relands", arbitrary things that are observed or conceived to differ from each other, while s is just the synetic intension or syntax which describes or defines them.

The generic syndiffeonic relation is "self-dual" in another sense as well: it has dual active and passive interpretations. It can be understood as the passive parallel or sequential assimilation of perceptual content through accepting syntax, or dually as the active, generative distribution of syntax over defined content (generative in the sense that the content does not technically exist prior to its formative syntax; pure cognition is virtually always generative, as it is inherently internal, subjective, and without external percepts by which the subject can be passively imprinted). It thus describes not only passive perception, with the synetic level equating to accepting syntax through which the diffeonic instances are recognized, but the generative conatus through which instances or values are brought into being.

This leads us to a third sense in which a syndiffeonic relation is self-dual: it relates cognition and perception, the subjective and objective aspects of reality. Where it is perceptually interpreted, its synetic level is associated with the subject as accepting syntax or generative conatus, while its diffeonic level is associated with percepts or objects of perception. The distribution of the synetic level of a syndiffeonic relation generates a medium. (A medium is a pointwise distribution of syntax. When a syndiffeonic relation is understood as a distribution of synetic syntax over diffeonic points, it functions as a logical "spacetime diagram"; its arity axis is spatial, while its ordinal axis is temporal. By logico-geometric duality, logical binding is dual to topological bounding, and syntax functions as a metric for the medium over which it distributes.) Where hological means "having the property that overall structure is distributed on all scales", the hological distribution of syntax throughout this medium makes it a connection among the diffeonic elements and subsets thereof. The intension "connects" the extension, imparting to the extension a degree of connectivity and coherence.

To sum it up: whenever, in the course of perception and/or cognition, one simultaneously recognizes any number of things as different from each other (discernible), one is necessarily bringing to bear a cognitive- perceptual syntax in order to accept both of them as cognitive or perceptual input, which amounts to distributing over them a common property. This common distribution belies any assumption that

they are utterly different and therefore subject to dualism. Instead, they are syndiffeonically related, differing only against a homogeneous background of common syntax or cognitive sameness.

Because syndiffeonesis relates cognition and perception, our only means of knowing reality, it comprises the universal relational structure of the identity of reality, characterizing sameness and difference, generality and specificity, intension and extension, invariance and variation, set-theoretic aggregation and discernment, and so on. In effect, it brings the apparatus of apprehension and attribution into every relationship that is thought or perceived, permitting it to model an attributive coupling in a self-contained fashion.

SCIENCE AS THE IDENTIFICATION OF REALITY

The objective of science is the identification of reality, i.e., to express the identity of reality as clearly and succinctly as possible. "The identity of reality" means "that as which reality can be coherently identified, or apprehended and locally discerned from nonreality"; it identifies reality as a discernible cohesive entity.

An identity is a coherent, stratified, self-dual syndiffeonic relationship. Stratified means that the synetic level distributes over the diffeonic level as a common property, while self-dual means that both levels coincide in a single coherent entity (the syndiffeonic relationship itself). Where the synetic level is regarded as intensional and the diffeonic level as extensional, the identity is just an attributive coupling of intension and extension, i.e., of a label, attribute, or description with the set or other structure which it describes. An identity, or intension | extension coupling, is self-dual in the sense that the coupling distributes over both coupled entities; on this level of meaning, the coupling relation is symmetric regardless of any asymmetry on other levels.

Algebraically, an identity represents an entire algebraic system of which it may or may not be a distinguished element. In either case, it is trialic in the sense that the system it represents contains elements, relations, and operations, which means that the identity plays all three of these roles. Mathematically, this can be expressed as follows:

E.1 $i = i\,R\,i = i * i,$

where i is an identity, R is a generic relation, and * is a generic operation. This means that where i is the identity of a system S which it therefore represents, any relation or operation under which S is closed instantiates the generic identity relation i R i and/or the generic identity operation i * i, and can therefore replace it under substitution, denoted --->. Thus, where a and b are two related elements of S, and R' and *' are a specific relation and a specific operation on S, we have the following substitutions:

i R i → a R' b

i * i → a *' b

→ a *' b

These simple examples illustrate the syndiffeonic aspect of identity. The identity itself, along with its generic R and *, reside on the synetic level, while its possible specifications i → (a or b or ...), R → R', and * → * reside on the diffeonic level.

Note, however, that as conventionally understood, the operational and relational closure of an algebraic system does not imply that its identity is completely self-contained. Instead, the mathematician and any required display, storage, or processing media are typically missing from its formal idealization, and it is usually considered to exist in a Platonic realm beyond which no explanation is required. In a ToE, this is unacceptable.

THE METALINGUISTIC IDENTITY OF REALITY: STRUCTURE AND DYNAMICS

The maximal generality (universality, comprehensiveness) criterion of a reality-theoretic identity, or ontologically necessary and sufficient "Theory of Everything", means that a fully general formal structure must be selected as the skeletal identity or ToE framework of reality. This structure is distributive by definition, applying hologically to every point and part of reality. Conversely, because this structure represents the entirety of the ontologically self-contained system from which it is induced, it is the ontic identity of that system.

Reality is formulated in mathematical terms, and mathematical structures, along with the various cognitive and perceptual structures they describe, can be scientifically formalized only as languages. Even the theory of languages is itself a language. This rule applies without exception, covering all quantitative equations and/or "master equations" purporting to describe reality; they too are languages, formalistic and meaningless without embedment in a ToE metalanguage formulated as an overall description of reality. It follows that the ToE identity must incorporate not only syndiffeonic structure, but the formal structure of a language, refined to whatever degree may be necessary. As always, the structure of the language (and syntactic and semantic consistency) is preserved by its model-theoretic mapping onto and into its universe, which means that the universe shares the linguistic structure and dynamics of the theory and is therefore also a language.

Language is often mistakenly conceived as the opposite of mathematics. It is

thought to be structurally loose and semantically nebulous, whereas mathematics is thought to be tight, clear, and unequivocal. In fact, not only is language a mathematical structure in its own right, but it is the most general mathematical structure of all, subsuming every other. If language were not mathematical in every sense, and if it were not capable of concise and unequivocal expression, then not only would mathematics (and therefore mathematical physics) be inadequate to characterize reality, but there would be no such things as mathematics and physics at all.

However, reality is not "just a language". It is a very special kind of language which possesses properties never before seen in a language outside the work of this author. These are the properties without which the mathematical structure of language cannot serve as the structure of reality, and without which reality theory would be futile. It would be futile because the word theory is just an abbreviation of theoretic language, and any theory at all must impute its own linguistic structure to reality as its content ... and in the case of a ToE, as its form and content alike.

Dynamically, the most interesting feature of the ToE master-language is that it evolves in two orthogonal directions. One mode of evolution occurs in the familiar linear read-write direction; for users of the English language, this is horizontally from left to right (we ignore the downward succession of lines on a page; the important thing is that each line is written and read from left to right). The other, which occurs in the perpendicular direction, can be variously exemplified as, e.g., (1) a mathematical calculation or axiomatic derivation in which one starts at the top of a page with a horizontally written initial statement and uses axioms and rules of inference to work downward through a series of modified statements, finally terminating on the bottom line or conclusion; (2) a cellular automaton which begins as a horizontal line of contiguous colored squares or cells, and evolves downward line by line as chromatic transformation rules are applied to the cells of each line in succession; and (3) a grammatical derivation in which, by a series of substitutions, a start symbol evolves through a derivational series of nonterminal expressions to a communicable terminal expression.

As a language couples to its content on the syntactic and semantic levels, orthogonal evolutionary processes analogous to those of the language are induced in the content. Where the content of the language is an appropriately structured manifold, the manifold in question also evolves in two orthogonal dimensions. One of these dimensions is the terminal dimension; this dimension is then correspondent to axiomatic or grammatical derivation, comprising an orthogonal dimension of causation with orthogonal sequences of pregeometric nonterminals. Where the manifold is spatiotemporal, and the terminal dimension of its evolution is understood as timelike, causal, and physical, the grammatical dimension of evolution is metacausal,

metatemporal, and metaphysical. It coherently transforms entire spatiotemporally extended systems rather than local states; it is not subject to local confinement as is terminal causation, which consists of many separate threads, but has nonlocal coherence and combinatorial (relational and operational) degrees of freedom which let it take the physical states of spatiotemporally extended systems as input and yield extended complexes of physical events as metasimultaneous output (where *metasimultaneous* means "occurring within the same null grammatical process").

Metacausation and other metaphysical criteria require that the standard "physical" conception of spacetime be superseded by a more advanced metaphysical conceptualization that is logico-geometrically dual to the linguistic structure of the trialic identity. Called the conspansive manifold, it is self-generative and requires three levels of topology and three corresponding levels of quantization. The conspansive manifold is dynamically self-contained; in coupling with the linguistic identity, it evolves by generative self-modeling, embedding conventional spacetime as a linear-ectomorphic semimodel corresponding to the semilanguage Lo of the ToE identity.

PROPERTIES OF THE METALINGUISTIC IDENTITY OF REALITY

The ToE must be intelligible, and must render reality intelligible as its content. This does not mean simply that the theory can be understood by its readers; it means that as a formal representation of the universal structure of reality, it is the distributive syntax of reality, and must enable reality to recognize itself through its elements and subsystems. It must comprise a distributive identity through which reality can not only be recognized by sentient entities, but which supports the states, state transformations, and interactions of inert entities, with different kinds of entity responding (only) to the appropriate syntactic invariants.

Explanation is the identification of prior cause or reason, an identificative regress intended to distinguish the explanandum from its negation. A global theoretical language L, being totally self-contained and thus self- explanatory, exhibits the property of inductive idempotence (ontic closure, existential self-sufficiency), amounting to the self-verifiability of reality as demanded by its self-containment (which is self-evident insofar as anything capable of supporting, constraining, or affecting reality is real by definition).

To say that a language or system is inductively idempotent means that under the operation E of explanation or explanatory regression, the operand or explanandum L is unchanged:

E.2 E(L) = L

where arbitrary n-ary operations on a set or structure S can be represented as mappings from Sn to S. Being existentially complete, L returns only itself when E operates on it.

In other words, explanatory induction is a recursive trialic identity mapping on L, with L playing the roles of explanandum, explanation function, and explanation. In short, for an inductively idempotent system, explanation is equivalent to identification; the system is its own identity, and the system is dually (formally and topologically) self-distributed over its own fundamental constituents or points (distribution of syntax over a point denotes the logical binding and/or topological bounding of a coherent element by the syntax; the point and its structure and dynamics must conform to all applicable syntactic forms and constraints). The origin or first cause of the trialic metaphysical metalanguage L can be apprehended only through L-syntax, which is invariant by definition and changeless under self-iteration. At the explanatory limit where explanation is global self-identification by the inductively idempotent identity-operator, it is called logical induction (which this paper exemplifies as both a description and an application). Logical induction equates to a form of deduction in which global syntax, including its own quantization mapping onto reality, is generically educed from the initial ingredients of reality, namely perceptual reality and accepting syntax (respectively, the objective and subjective aspects of reality, of whose elementary coupling science and experience undeniably consist).

The ToE identity must be logically consistent so that no irresolvable paradoxes destroy its intelligibility (or that of reality at large). Where physics is idealized as a first-order language capable of expressing all object-level truths about physical or perceptual reality, the ToE must be a metaphysical metalanguage of physics which supports the verification or falsification of physical attributions by attaching one of the truth values (T,F) to each of them. For this, the 2-valued T|F distinction of propositional logic is required, and because propositional logic is just a special sublanguage of predicate logic (as is model theory), predicate logic as an (operationally defined) whole is required. As a requirement of intelligibility and thus of science, logic comprises the top-level structure of the identity of scientific reality, distributing over every point of its medium (i.e., every coherent, discernible diffeonic reland). Where the meaning of logic boils down to "the rules of valid thought and perception", logical structure doubles as cognitive-perceptual syntax. It is through this logical syntax that a self-modeling (conscious) entity couples "anthropically" to its universe and "meta-tautologically" identifies itself in contradistinction from its environment and vice versa (for an explanation of the metatautology concept, keep reading).

In order to have any degree of certainty, the ToE cannot rely on assumption, or

empirical or probabilistic induction. What is required is logical-inductive reasoning from known specifics to generalities by tautological necessity. These initial specifics are just what we are given without inference, namely perceptual reality and cognitive-perceptual accepting / generative syntax (including what Kantians sometimes call the "categories of thought and perception", and what philosophers of mind call qualia). The ingredients of this reality-syntax need not be enumerated in order for it to serve as a basis for logical induction; if syntax is instead functionally or operationally defined and distributed over reality through its universal syndiffeonic relational structure – i.e., as the synetic level of a global syndiffeonic relation - the implications are already far from trivial.

One very important application of logical induction relates the two initial ingredients of reality just mentioned: the external world of objective perceptual content, and the internal world of cognition and the syntactic and semantic structures to which it conforms. These two ingredients, which are given and need not be assumed, are related by a mapping that can be simply expressed as

$$M{:}L \leftrightarrow U$$

where L is a language of cognition and perception along with the formal, ideal, or abstract ingredients of that language (includes cognitive-perceptual accepting syntax in its entirety), U is the universe of the language, e.g. the perceptual universe, and M is the metalanguage expressing the mapping of L to U and U to L via the two- headed arrow "$\leftrightarrow$", which can represent cognition, perception, attribution, recognition, information, or anything else that bridges the dualistic gulf between form and content.

The mapping M may look unimpressive, but it is deceptively powerful. It is a minimal model of cognition and perception (and attribution and information as well), and is capable of exhibiting all of the essential ToE properties mentioned above. It is also just another way of looking at a syndiffeonic relation, and is therefore a model of relational structure; U is just a set of discernible entities or diffeonic relands, while L incorporates the synetic intension of any given subset of U, with M taking responsibility for the distribution of L over U. And last but not least, it is also a way of characterizing the global identity of reality, a compact model of thought and experience which forms the nucleus of advanced reality theory.

A few observations regarding the above mapping are in order. First, the whole thing can be contracted to M alone. For as we have already mentioned, a metalanguage like M must include its object-language L, and L must syntactically embed its content. So

E.3 $M = (M \supset L \supset U)$

In other words, reality can be entirely packaged in the ToE metalanguage M. However, this requires a bit more explanation. For example, (1) the intensional language L is operator-quantized; (2) M is "meta-surjectively" mapped onto the L-quanta with a special hological kind of one-to-many mapping (M is coherent and therefore "singular", whereas L-quantization produces many L-operators); (3) the two $\supset$ signs carry different senses of inclusion; and (4) L "metrizes" U, inducing on it a dual geometry.

Secondly, there is an aspect of syndiffeonesis that we have not yet discussed: a syndiffeonic relation amounts to something called a metatautology or "self-dual tautology". Whereas a propositional tautology generally amounts to an element of logical syntax roughly equivalent to the self-identity of a sentential variable (e.g., "X=X", X an arbitrary attribution), and a semantic tautology is a similar redundancy within a specific attribution (e.g., "a horse is a horse" or "a rose is a flower"), a metatautology is a self-dual "input-acceptor redundancy" whereby an input datum doubles as an element of the accepting syntax of the acceptor (or generic observer or thinker). The shift of data type (of an identity) between percept and percipient, the thing observed and the accepting / generative syntax of the observer, is a dualization operation, i.e., the symmetric rotation of a self- dual identity between logical data types, in this case perceptual input and cognitive-perceptual syntax.

Having defined a metatautology, we can now expand the concept by making use of our two initial ontological ingredients, the two things that we are absolutely given without assumption upon birth into this reality, the esse est percipi and cogito ergo sum of reality theory: perceptual reality, or the objective environment consisting of external states, and cognitive-perceptual syntax or mind, consisting of the subjective inner world of mental internal states and state transitions.

First, note that in addition to the two initial ingredients L and U, we are also given the coupling between them; this is M, and we are implicated in M as entities in which the L|U coupling occurs. As an identity, M can be considered one coherent entity which self-differentiates by syndiffeonic self-stratification through the cumulative factorization of telesis, a dual generalization of energy properly defined to serve as the ultimate "stuff" of reality. Thus, rather than going through a sequence of steps to construct M, we are simply explaining how the aspects of M:L$\leftarrow\rightarrow$U interrelate, breaking up the explanation into parts and steps for the sake of clarity. The steps do not occur as a temporal sequence, but metasimultaneously; the ingredients M, L, and U are interdependent and mutually recursively defined with respect to function (although M can be considered to stand alone as a self-potentializing, self-actualizing

global identity creating L and U in the course of self- identification).

(a) U is the entire universe of replicable perceptions, or the object-level universe of the first-order language L. Conversely, L is the comprehensive first-order intension of U (which is dual to its extension or object-universe U). This is an irreducible mutual recursive definition of L and U:

E.4 $L=F_L(U)$; $U=F_U(L)$

where FL and FU are definition functions with their parameters (definientia) in parentheses. In other words, the definition of each definiendum (defined term) L and U necessarily takes the other term as a definiens (definitional parameter). This definitional linkage is ontological; it does not say merely that percepts must be perceived and properties substantively instantiated, but that states in U are meaningless without attributes in L, and attributes in L are unassignable without attributive operators in U. L and U cannot be separated, and U is therefore equivalent to a particular L|U coupling within the metaobject domain {L|U} consisting of all possible couplings of entities from L and U respectively.

(b) As related entities, L and U comprise a relational identity M = M:L←→U which equates to a logically idempotent form of model theory, the CTMU, that can not only couple L and U, but can also couple itself to L, U, and the L-U coupling L|U, and so on to arbitrarily high order.

Where observable states of the perceptual universe U are couplings of attributes from L with values from U,

E.5 M:L←→U = M:L←→ (L|U) = M : L←→{L|U}

Anything not sharing the structure of L is inexpressible in L, and because L amounts to cognitive-perceptual syntax and thus limits perception and conceptualization on U, nothing is perceptible or conceivable which is not expressible in L. That is, the perceptual universe U, which coincides with the (time-dependent) coupling L|U and the inclusive metaobject domain {L|U} forming the universe of M (the syntactic metaverse), contains nothing which is not in structural correspondence with cognitive-perceptual syntax L; U is entirely embedded in L as perceptual content, and secondarily, as inferred properties and relationships of perceptual content. The mapping may thus be contracted, retracting U = L|U = {L|U} entirely into L and leaving M:L.

(d) By duality of the syntactic distribution of the metalanguage M over its object language L, L retracts into M, so that everything resides in the global identity:

E.6 M:L → M [→ M':M←→{L|U} = M":M←→{M|LU} = …, by the logical idempotence of M]

Saying that M distributes over L amounts to saying that it distributes over points of L, i.e., syntactic operators and their coupled state-transitional identification events, which are in turn locally embedded in M. The syntactic self-distribution of M involves self-similarity mapping called d-endomorphism, in which M "self- quantizes" as trialic self-operators (acceptors and/or generators) coinciding with relationships and identification events ("measurements"). Basically, this creates localized, attenuated copies of M immersed in a hological medium everywhere identical to M. D-endomorphism describes the past-to-future direction of time (and the inward direction of space); the dual mapping, evolution or d-ectomorphism, has the opposite spatiotemporal directionality. These mappings occur only together in a spatiotemporally symmetric metaprocess called conspansion, where they define primary (potentiative) and secondary (actualizative) stages of causation respectively associated with wavefunction propagation and collapse. This requires orthogonal (causal and metacausal, mechanical and telic) modes of quantization associated with not only physical state and state-transition, but adaptive syntax-state (medium-content) relationships of arbitrary order.

The end result is a self-quantized, self-stratified trialic identity M = (M ⊃ L ⊃ U) which is simultaneously equivalent to the perceptual universe U, the cognitive-perceptual language L, and an idempotent metalogical metalanguage which models itself by iteratively coupling L and U while coupling itself to the metaobject domain {L|U} and its inductive successors to arbitrarily high order.

According to its structure, M is a supertautology, that is, a comprehensive, ontically self-contained metalanguage of reality which is equivalent to reality itself … a reflexive self-recognition / self-generation operator whose reflexiveness amounts to a generalized form of consciousness heritable by its quanta. Nothing which violates the supertautology can ever break into it, or maintain a relationship with it at or below the level of the violation. A local identity in conflict with the global identity M is ultimately annihilated.

A supertautology is self-verificative, as it injects logic – including the tautological propositional level of predicate logic and the supertautology itself – into its own quanta as accepting and generative syntax, which are supported and constrained by it. A supertautology thus limits reality to just that over which it distributes (including itself); anything over which it does not distribute is neither supported nor constrained by it, and is therefore unintelligible and tautologically excluded from the reality of which it is

the hological identity and unique source of coherence and intelligibility. In short, M is a self-identification operator which not only identifies and verifies itself, but excludes its negation; that which fails to conform to the most general level of accepting syntax, namely logic, cannot be accepted as cognitive-perceptual input, or for that matter as an ingredient of reality theory.

As observed above, logical induction is just an identity mapping on an inductively idempotent logical identity- operator. Self-identification by the reality-theoretic supertautology equates to a universal trialic identity mapping which plays the roles of explanandum, explanation, and explanation-function (a function which accepts the explanandum as input and yields its explanantia as output). Shifting the terminology to the model- theoretic level of predicate logic, we now see that the identity mapping plays the roles of universe, language, and model.

The trialic supertautological identity M can be developed into the Cognitive Theoretic Model of the Universe or CTMU, a reality-theoretic structure with formal-linguistic, geometric, and model-theoretic aspects. Because its formal aspect is called *Self-Configuring Self-Processing Language* or SCSPL while its geometric aspect is called the *Conspansive Manifold* or CM, it is sometimes written "SCSPL | CM" to convey its global logico-geometric (form | content, language | universe) duality. Due to the way the geometry of reality couples with the identity- metalanguage M = SCSPL, physical (perceptible) reality is everywhere directly immersed in metaphysical (global-identic) reality.

In the first decade of this millennium, the CTMU was succinctly described as follows:

> **Interviewer**: Can you sketch the CTMU -- in plain English -- for our readers?
>
> **CML**: The name literally says it all. The phrase "Cognitive-Theoretic Model of the Universe" contains three main ingredients: *cognitive theory*, *model*, and universe. Cognitive theory refers to a general language of cognition (the structural and transitional rules of cognition); universe refers to the content of that language, or that to which the language refers; and model refers to the mapping which carries the content into the language, thus creating information. The way in which the title brings these three ingredients together, or "contracts" their relationship to the point of merging, reflects their perfect coincidence in that to which the title implicitly refers, i.e., reality (the physical universe plus all that is required to support its perception and existence). Thus, the CTMU is a theory which says that reality is a self-modeling universal language, or if one prefers, that *the universe is a self-modeling language*.

The operation of combining language, universe, and model to create a perfectly self-contained metalanguage results in SCSPL, short for Self-Configuring Self-Processing Language. This language is "self-similar" in the sense that it is generated within a formal identity to which every part of it is mapped as content; its initial form, or grammatical "start symbol", everywhere describes it on all scales. My use of grammatical terminology is intentional; in the CTMU, the conventional notion of physical causality is superseded by "telic causation", which resembles generative grammar and approaches teleology as a natural limit. In telic causation, ordinary events are predicated on the generation of closed causal loops distributing over time and space. This loop-structure reflects the fact that time, and the spatial expansion of the cosmos as a function of time, flow in both directions - forward and backward, outward and inward - in a dual formulation of causality characterizing a new conceptualization of nature embodied in a new kind of medium or "manifold".

SUMMATION

In sum: there are two kinds of causality in the CTMU, mechanical and telic. Telic causation is associated with conscious self-modeling entities, i.e., entities with sufficient mental coherence and complexity to internally model the relationship between self and environment (this being the kind of entity which can meaningfully participate in the self-identificative evolution of M by self-modeling, which happens automatically with embedment in M). Reality is usually understood to evolve along an ordinal parameter, time, as a sequence of spatial distributions of matter and energy, with allowance for perspectival variation. Treating reality as a unique kind of language, the CTMU shows that it is instead generated or grammatically produced by a telic (self-generative) grammar which operates dually to standard terminal causation and orthogonally to time.

SCSPL can be factored into a pair of semilanguages Ls and Lo, which are respectively dynamical and static and associated with the conspansive model and the linear-ectomorphic semimodel of the CTMU. Standard physics is largely confined to the linear-ectomorphic semimodel, which is retroscopic. In the CTMU, (meta)causation and dynamics reside solely in SCSPL. Ordinarily, the geometry of reality is described as a spatial or spatiotemporal manifold, the structure of which is usually explicated as a fiber bundle. However, a fiber bundle resides in the linear-ectomorphic semimodel and thus lacks support for its own evolution. The CTMU describes the geometry of reality using a more sophisticated structure associated with the self-dual conspansive model, which evolves metacausally and orthogonally to the terminal (temporal, ordinal) axis. Unlike the linear-ectomorphic kind of manifold

usually employed in physics, the conspansive manifold has the characteristics required of a true universal medium, accommodating causal quantization requirements while incorporating General Relativity as a linear-ectomorphic terminal limit.

In the CTMU, the Lagrangian formalism of mainstream physics is merely the timelike image of a more general CTMU process, telic recursion, which accommodates a generalization of so-called physical causation called telic causation. The CTMU effects this accommodation by incorporating full support for the metacausal-grammatical dimension of causation. Its "spacelike" telic feedback, orthogonal to time, is what other theories mistake for "causation and retrocausation", which are confined to terminal event-sequences in the linear-ectomorphic semimodel. In particular, any quantum Lagrangian fits into the conspansive manifold as a conspansive cycle embedded in a conspansive metacycle or quantum of telic metacausation. The CTMU interpretation and extension of quantum mechanics, Sum Over Futures (SOF), is a generative "quantum metamechanics" supporting this embedment.

In the CTMU, quantum mechanics is modeled rather than merely interpreted. Unlike a mere interpretation, a model is logically valid; unlike a conventional "interpretation" of quantum mechanics, a QM model has a definite codomain. Without a verifiable "pre-quantum" picture of reality, the codomain of a QM-interpretative mapping is indefinite, precluding its validation as a real "model" (the absence of a model alone ensures the invariance of quantum mechanics under interpretative variation). Where a valid ToE is lacking, it cannot be decided which (if any) QM interpretations are correct, or how they relate to each other. In fact, QM itself defies verification on its own merits, and the field of QM interpretation is arguably pointless except insofar as it points toward the deeper structure of reality.

Independently of arguments for the Holographic Principle in string theory, the CTMU logically establishes that the universe is indeed a holographic self-simulation. The difference between the stock cosmic hologram and the CTMU "hologram" is that the latter is a trialic hological language which, because it is a metaevent and metaprocess as well as a metaobject and metarelation (the metacausal analogues of event, process, object, and relation), displays spatiotemporal closure. As required by the self-distribution of M (and arguably by the definition of "hologram"), the cosmic hologram is replicated in every identification event or internal point of the conspansive manifold. In the CTMU hologram, reality everywhere "simulates itself" through, and for, its own constituents.

As might be expected, there is much more to this story. The CTMU theory-universe-model dates from the mid- 1980's, and has since been extensively developed in nearly total isolation from the academic community.

Please bear in mind that this paper contains only a minimal introduction.

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