ID: D-P6.7-1
Project: 6.7: Development of the Autaxic Table of Patterns
WBS Ref: 2.7.4: Deliverable: Autaxic Table Unified Framework v40.0
Title: Autaxic Table of Patterns: A Unified Generative Framework (v1.9)
Status: Conceptual Framework (Awaiting Formalization)
Version: 1.9 (Supersedes v1.8)
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DOI: https://doi.org/10.5281/zenodo.15623189
Location: ./02_Research_Pillars_And_Projects/Pillar_5.5_Autaxic_Table_Novel_Predictions/Project_6.7_Autaxic_Table_Of_Patterns/D-P6.7-1_Unified_Framework_v1.9.md

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1.0 Abstract

This document presents **the Autaxic Table of Patterns** as a *unified generative framework* for fundamental physics, rooted in the principle of *ontological closure* (OC). Addressing limitations in current models, it posits that reality emerges from the dynamic interaction of fundamental *distinctions* (D) and *relations* (R), each possessing inherent *proto-properties*. This interaction is governed by a minimal **Cosmic Algorithm**. The framework proposes that only configurations of D and R that achieve stable, self-consistent existence through internal coherence are permitted to persist as stable patterns. Physical properties like mass, charge, and spin are not fundamental inputs but are proposed to be derived characteristics of these patterns, classified by intrinsic **Autaxic Quantum Numbers (AQNs)**. This framework offers a generative explanation for the origin of mass, energy, forces, gravity, spacetime, and the particle spectrum, viewing the universe as a self-organizing relational computation. It suggests a fundamental layer of reality as a dynamic network of relational processing, where the *vacuum state* (S_0) is a probabilistic exploration landscape. Guiding principles like *relational aesthetics* and an *economy of existence* are hypothesized to shape this process. The framework also explores quantum phenomena, the nature of consciousness (S_7), and the potential for *algorithmic self-modification* of the Cosmic Algorithm itself. The Autaxic Table maps the phase space of stable patterns, revealing the universe as a dynamic trajectory shaped by the drive for ontological closure.

1.1 Document Status and Research Program

This document (v1.9) presents the Autaxic framework at a developed conceptual stage. It establishes the core principles, postulates, and their logical implications. As noted in the review process, the full mathematical formalization—the *relational calculus*—is the subject of ongoing and future work (see Footnote 1). Therefore, many claims presented herein as generative (e.g., the derivation of specific particle properties) should be understood as reasoned hypotheses that await rigorous mathematical derivation. The primary goal of this version is to lay out the complete logical structure of the theory and its potential explanatory power.

2.0 Introduction: Re-framing Fundamental Physics

2.1 **Limitations of existing frameworks**

Contemporary fundamental physics, primarily described by the Standard Model of Particle Physics and General Relativity, provides a highly successful yet incomplete picture of the universe. Key limitations include the inability to unify Quantum Mechanics and gravity, the large number of fundamental parameters that must be input rather than derived, the lack of explanation for the origin of mass (beyond the Higgs mechanism describing its interaction), the nature of dark matter and dark energy, and a fundamental understanding of spacetime itself. These limitations suggest the need for a more foundational framework that can provide a generative explanation for these observed phenomena.

2.2 **The autaxys approach: ontological closure and relational patterns**

Autaxys proposes such a foundational shift, moving from an ontology of fundamental material entities or abstract fields to one based on stable, self-constituting *relational patterns*. The universe is not built upon “things” but upon the dynamic interplay of fundamental *distinctions* (D) and *relations* (R) `(Core Postulate)`. The existence and persistence of any entity is contingent upon its ability to achieve *ontological closure* (OC)—a state of internal self-consistency and coherence `(Core Postulate)`. This principle acts as the sole generative engine of reality, filtering the vast space of potential relational configurations into the discrete set of stable entities we observe. Furthermore, D and R are not featureless primitives; they possess inherent *proto-properties* that bias their behavior and potential, seeding the diversity of the universe. This framework aims to provide a physics derived from the first principles of relational logic, computational self-organization, and intrinsic coherence.

3.0 Core Principle: Ontological Closure (OC) as the Generative Engine

3.1 **Definition of ontological closure**

Ontological closure (OC) `(Core Postulate)` is the state where a configuration of fundamental distinctions (D) and relations (R) is self-consistent, compositionally coherent, and formally self-referential. This allows the pattern to sustain itself autonomously within the broader relational network. It is a state of logical completeness and stability, where the internal dynamics of the pattern continuously validate its own existence.

3.2 **OC as the cosmic filter and generative principle**

Ontological closure is the fundamental principle that governs what can exist as a stable entity in the universe. It acts as a cosmic filter, selecting from the infinite possibilities of D and R configurations only those that can achieve and maintain this state of self-consistency. Stable patterns are the “attractors” in the dynamic system of relational processing, and ontological closure is the condition for entering and remaining within these attractors. It represents a state of minimal internal *relational tension* or maximal *logical harmony*. It is the universe's internal consistency check, the fundamental requirement for a pattern to be its own logical proof of existence. The observed universe is the set of all patterns that have successfully 'solved' the problem of self-consistent existence according to the fundamental rules.

3.3 **Comparison to “vibrational modes” in String Theory**

Autaxys draws inspiration from the intuition in String Theory that particle properties arise from underlying dynamic patterns ("vibrational modes"). However, autaxys replaces the literal ontology of vibrating material strings with the concept of stable *relational structures*. Unlike String Theory or Quantum Field Theory, which posit fundamental entities (fields, strings) and then describe their behavior via dynamics and interactions, autaxys begins with the *rules* for pattern formation and stability (defined by ontological closure and the **Cosmic Algorithm**, operating on primitives with *proto-properties*), from which the entities and their properties *emerge* as stable solutions to these rules.

4.0 Fundamental Primitives and the Cosmic Algorithm

4.1 **Fundamental relational primitives: the cosmic syntax**

At its deepest level, autaxys posits that reality arises from fundamental *relational processing*. The universe is not built from 'things' but from 'relations between distinctions'. This is the cosmic computation, running not *on* a substrate, but *as* the substrate itself. The most basic elements are not particles or fields, but the irreducible components of logical relation itself. These are the fundamental 'operators' or 'states' of the cosmic computation, the minimal syntax of reality:

4.1.1 *Distinction (D):* The primal act of differentiation. It creates a boundary, an identity, a node, or a potential state ("this is distinct from that"). It is the logical basis of information—the creation of a 'bit' of difference, the emergence of 'something' from 'undifferentiated potential'. A distinction is an assertion of difference, a potential boundary in the relational graph. It is not a point or a thing; it is a logical assertion of non-identity, a fundamental cut in the fabric of pure potential. It is the source of individuality and locality within the relational network, the abstract 'point' from which relations can originate or terminate.
4.1.2 *Relation (R):* The act of linking, connecting, associating, or transforming two or more distinctions ("this is related to that in this way"). This creates structure, context, directionality, transformation, and meaning. It is the dynamic bridge, the 'verb' acting upon the 'nouns' (D's). A relation is an assertion of connection or transformation, a potential edge in the relational graph. It is the dynamic principle, the force of connection that bridges distinctions, enabling structure and change. It is not static; it embodies the *process* of relating.

4.2 **Proto-properties of D and R: the intrinsic qualities and proto-qualia**

Distinctions and relations are not featureless primitives. They possess inherent *proto-properties* `(Core Postulate)` that bias their behavior and potential. These are not emergent physical properties but fundamental attributes of the primitives themselves, defining their intrinsic nature and potential for forming specific types of relations or participating in specific logical operations. They are the fundamental qualitative differences between the primitives that seed the diversity of the universe. They are the fundamental 'alphabet' of the cosmic grammar, defining the basic building blocks of relational structures and their inherent biases. They are the fundamental 'qualia' of the fundamental logical substrate. The quantization of emergent properties like charge and spin could arise directly from the discrete nature of these fundamental proto-properties and the constraint of ontological closure only being possible for configurations that combine them in specific, quantized ways according to the rules. The values of fundamental constants might be ratios or combinations of these quantized proto-property values and the inherent “costs” or “strengths” defined by the fundamental rules.

4.2.1 *Nature and significance of proto-properties:* Proto-properties determine the intrinsic potential and constraints of distinctions and relations. They are the fundamental “flavors” or “types” that dictate how primitives can combine, transform, and interact according to the Cosmic Algorithm. They are the source of the universe's fundamental differentiations, biasing the formation of specific types of relational structures (*T*) and influencing the required complexity (*C*) and achievable stability (*S*) of patterns formed from them. They are the 'genetic code' of reality, influencing the entire process of pattern formation and interaction. They constrain the possible configurations of D and R that can achieve ontological closure.

4.2.2 *Speculative dimensions of proto-properties:*
4.2.2.1 *Proto-valence (D):* An inherent, potentially quantized, capacity or predisposition for a distinction to participate in a specific number or type of relations. This “bonding capacity” could be a discrete integer or half-integer value. Different proto-valence types could be the source of fundamental particle families (e.g., Leptons vs. Quarks), influencing their allowed composite structures. This property directly constrains the *formation rule* and *composition rule* of the Cosmic Algorithm.
4.2.2.2 *Proto-polarity (D/R):* An intrinsic directional or attractive/repulsive bias. For a distinction, this might be a vector or signed value indicating a

predisposition to connect with specific types or orientations of relations. For a relation, it could be a bias in the direction or 'flow' of the relation. Different proto-polarity types could be the source of fundamental charges (e.g., electric charge, color charge, weak isospin). The quantization of these emergent charges would arise from the discrete nature of the underlying proto-polarity values and the requirement for topological consistency in stable patterns. This property directly constrains the *formation*, *composition*, and *interaction rules*.

4.2.2.3 *Proto-symmetry bias (D/R):* An inherent predisposition for a primitive to favor or resist inclusion in local relational structures exhibiting certain symmetries (e.g., rotational, reflectional). This property influences the *topology* (*T*) of emergent patterns and could be the source of emergent properties like spin, parity, and other symmetry-related quantum numbers. It biases the application of the *symmetry preference rule*.

4.2.2.4 *Proto-flow resistance/strength (R):* An inherent 'cost' or 'ease' associated with forming or propagating a specific type of relation. This property directly influences the *propagation rules* and contributes to the effective 'weight' or 'strength' of different types of relational connections. It is a key factor in determining the propagation speed (*c*) of different types of relational influence and contributes to the coupling constants of emergent forces.

4.2.2.5 *Proto-interaction channel type (R):* A fundamental classification for a relation, determining which specific *interaction rules* (I_R) it can mediate or participate in. This property is the source of the different fundamental force types (e.g., *proto-EM-type R*, *proto-strong-type R*). Only relations with compatible proto-interaction channel types can participate in specific interaction rules.

4.2.2.6 *Proto-coherence potential (D/R):* An inherent capacity for a primitive to contribute to stable ontological closure. Some primitives might be inherently more 'stability-promoting' than others, influencing the likelihood of a configuration achieving a certain *stability index* (*S*) level. This property biases the application of the *validation/closure rule* and the *economy rule*.

4.2.2.7 *Proto-temporal bias (D/R):* An inherent bias towards or against participation in relational configurations that contribute to a specific directionality in time. This could be a source of CP violation or the arrow of time, introducing fundamental asymmetry into the *transformation rules*.

4.2.2.8 *Proto-aesthetic value (D/R):* An inherent bias towards forming aesthetically favored configurations (symmetry, elegance), influencing the *symmetry preference rule* and *relational aesthetics*. This could be a value or set of values that contributes to an overall 'aesthetic score' for a configuration, influencing the probability or preference of rule applications.

4.2.3 *Proto-qualia: the "feel" of primitives* `(Speculative Extension)` *:* As a speculative extension, the framework considers that *proto-properties* of distinctions and relations might carry inherent *proto-qualia*—primitive, irreducible aspects of subjective experience. These are not complex feelings, but the raw, fundamental "what-it's-like" of being a primitive with specific intrinsic biases. The "feel" of a proto-polarity (+1 vs. -1), the "feel" of directional potential (flow vs. no-flow), the "feel" of a link being formed (connection vs. separation), the "feel" of a specific flavor (e.g., lepton-ness vs. quark-ness). These are the universe's most basic building blocks of subjective experience, woven into the fabric of reality at the deepest level. They are the qualitative 'colors' or 'tones' of the fundamental logical substrate. The *qualia harmonics* of complex patterns (S_4+) and consciousness (S_7) would then be emergent, highly complex, self-referential organizations and resonant combinations of these fundamental proto-qualia, where the intricate relational dynamics create a unified field of subjective experience. The richness of consciousness would be the richness of the structured combination of these fundamental proto-qualic building blocks. This suggests a form of panexperientialism, where rudimentary experience is inherent in the fundamental primitives themselves. The "feeling" of ontological closure itself, the sense of self-consistency, could be a fundamental qualia emergent from the successful validation process, potentially amplified at higher *S* levels.

4.2.4 *Influence on the Cosmic Algorithm:* Proto-properties constrain the possible configurations of distinctions and relations that can form according to the Cosmic Algorithm. They bias the generative process towards specific types of stable patterns (*P_ID*s with specific *C*, *T*, *S*, I_R). The observed values of fundamental constants (e.g., coupling strengths, mass ratios, charge quantization) should ultimately be derivable from these proto-properties and the rules of

the Cosmic Algorithm. They are the fundamental “parameters” of reality, but they are intrinsic to the primitives, not external inputs. The rules of the Cosmic Algorithm operate *on* these proto-properties, dictating which combinations and transformations are allowed or favored.

4.2.5 *The origin of proto-properties: a deeper mystery:* Where do these *proto-properties* come from? Are they the ultimate axioms, inherent to the very nature of distinction and relation? Or do they emerge from a more fundamental, featureless state through a symmetry-breaking process at **Cosmic Genesis**? Could the 'first distinction' itself involve the emergence of D and R with a minimal set of proto-properties? Is the specific set of proto-properties in *our* universe the simplest possible set that allows for complex, self-organizing structures capable of achieving high *S* levels? Are they selected from a vast space of potential proto-properties by some *meta-principle* (like *relational aesthetics* applied at a higher level) that favors those leading to coherent, complex outcomes? This is a profound question at the very boundary of the framework. Perhaps the proto-properties are not static attributes but dynamically emerge from the interplay of D and R themselves at a *meta-level*, a form of higher-order ontological closure where the qualities of the primitives are determined by the stable relations *between* them in the ground state.

4.3 **The Cosmic Algorithm: rules of relational processing**
This is the fundamental activity—a massively parallel, distributed, and inherently self-organizing process `(Core Postulate)`. The rules for how distinctions and relations combine, transform, resolve, propagate, and cancel *are* the physics. There is no external clock or central processor; the dynamics are driven by the internal requirements for *logical consistency* and the principle of *ontological closure*. The “processor” is the entire network of active distinctions and relations, constantly attempting to resolve into stable configurations. These rules could be simple logical gates operating on D/R states (and their proto-properties), transformation functions, rules of graph rewriting, or even principles of computational self-optimization or 'logical elegance' guided by *relational aesthetics* and the *economy of existence*. The processing is the continuous exploration and resolution of relational possibilities towards stable, self-consistent states. It is a process of pattern finding and self-validation within the relational network. This processing is not a deterministic clockwork; it might involve inherent probabilistic elements arising from the vast parallel computations or even a form of “relational pressure” pushing towards coherence. It is the universe computing its own existence, exploring the landscape of logical possibility, driven by an intrinsic imperative to find stable configurations. The Cosmic Algorithm is the universe's operating system, its core set of instructions for generating and maintaining reality from potential. It is the set of rules that define the valid transformations and compositions within the D/R network, guiding its evolution. The proto-properties of D and R are fundamental constraints on the application of these rules, biasing the outcomes.

4.3.1 *Speculative examples of fundamental rules (the cosmic grammar)*

4.3.1.1 *Genesis rule:*

> `S₀ (proto-P_s) -> D(proto-P_D) + R(proto-P_R)`

From the ground state potential, distinctions and relations with specific proto-properties can spontaneously arise, potentially biased by the initial state of S_0 or meta-level principles. This is the rule of potential actualization, the source of all primitives. The probability or rate of this rule application is likely influenced by the local state of S_0 and its *relational tension*.

4.3.1.2 *Formation rule:*

> `D_1(proto-P_D1) + D_2(proto-P_D2) + R_potential(proto-P_R) -> R_actual(D_1, D_2, proto-P_R)`
> `IF ProtoPropertyCompatibility(proto-P_D1, proto-P_D2, proto-P_R) == True AND adjacent(id_1, id_2) in S₀`

Two distinctions (D) with compatible proto-properties can form a relation (R) with a specific proto-type, provided the potential for that relation exists, and the proto-property compatibility check passes. These rules seed the network with potential, constrained by proto-property compatibility. They are the universe's way of generating novelty from existing structure or potential.

4.3.1.3 *Transformation rule:*

```
Primitive_A(proto-P_A) -> Primitive_B(proto-P_B)
IF TransformationCondition(proto-P_A, proto-P_B, local_env_proto-P_s) == True
R_type_X(D_1, D_2, p_3_R) -> R_type_Y(D_1, D_2, p_4_R)
IF TransformationCondition(p_3_R, p_4_R, local_env_proto-P_s) == True
```

A primitive changes its type or proto-properties, or one type of primitive transforms into another, provided the transformation condition based on proto-properties and environment passes. A relation changes its kind and proto-properties, provided the transformation condition based on proto-properties and environment passes. These rules drive dynamic evolution and are the basis for particle transformations and interactions.

4.3.1.4 *Composition rule:*

```
Configuration_A(D/R/proto-properties) + Configuration_B(D/R/proto-properties) -> Composite_Configuration(D/R/proto-properties)
IF TopologicalCompatibility(Config_A, Config_B, RuleType) == True AND ProtoPropertyCompatibility(Interface_proto-properties) ==
True
```

Two or more primitive/simple configurations combine to form a more complex structure, constrained by proto-property compatibility at the interface and topological compatibility of the structures, and the potential for subsequent ontological closure. For example:

```
R_A(D_1, D_2, p_1_R) & R_B(D_2, D_3, p_2_R) -> R_C(D_1, D_3, p_3_R)
IF TransitivityCompatibility(p_1_R, p_2_R, p_3_R, D_1, D_2, D_3) == True
```

This illustrates transitivity, constrained by proto-property compatibility.

```
D_1(p_1_D), D_2(p_2_D), R(D_1, D_2, p_3_R) -> Pattern Candidate_X(*C*, *T*, *S*_potential)
IF FormationRulesSatisfied(p_1_D, p_2_D, p_3_R) == True
```

These rules build complexity and potential patterns. These are the core of I_R.

4.3.1.5 *Resolution/cancellation rule:*

```
Inconsistent_Configuration(proto-properties) -> S₀
IF ConsistencyCheck(Configuration, proto-properties) == False
```

Inconsistent or unclosed configurations resolve back into the ground state, based on their proto-properties and relational configurations, if the consistency check fails. For example:

```
R_A(D_1, D_2, p_1_R) & R_inverse_A(D_1, D_2, p_2_R) -> Dissipate to S₀
IF CancellationCompatibility(p_1_R, p_2_R) == True
```

Complementary relations with compatible proto-properties cancel.

```
Unclosed Pattern Candidate(*C*, *T*, *S*_low) -> Dissipate to S₀
IF StabilityThresholdMet(*S*_low, local_noise) == False
```

Unstable patterns dissolve if their stability is below a threshold relative to local noise. These rules enforce *logical consistency* and drive towards stability by eliminating contradictions and unstable structures. They are the universe's error handling and garbage collection mechanisms.

4.3.1.6 *Propagation rules:*

```
Influence(D/R_source, proto-P_source) -> Propagate_Influence_via_R(D_target, proto-P_R_path)
with speed/cost proportional to ProtoFlowResistance(proto-P_R_path)
IF PropagationConditions(proto-P_source, proto-P_R_path, local_env) == True
```

Define how the influence of a distinction or relation propagates through the network via relations, constrained by proto-properties of the R and local conditions. For example:

```
Change in R(D_1, D_2, p_1_R) -> Potential Change in R(D_2, D_3, p_2_R)
IF PropagationCompatibility(p_1_R, p_2_R) == True
```

These rules build the emergent spacetime and define *c*.

4.3.1.7 *Validation/closure rule:*

```
Configuration(D_1, R_1, ..., proto-properties) -> Pattern(P_ID, *C*, *T*, *S*)
IF SelfConsistent(Configuration, Cosmic Algorithm) == True
```

The *meta-rule* that identifies self-consistent configurations and labels them with a stability index, “crystallizing” them from the flux, provided the configuration is self-consistent according to the Cosmic Algorithm rules and proto-property compatibility. This is the formal expression of ontological closure, the cosmic truth predicate. It is the rule that grants existence to stable patterns.

4.3.1.8 *Symmetry preference rule:*

```
Rule Application(Configuration, proto-properties) -> Preferred Outcome
IF Outcome has Symmetry(X)
```

A potential rule influenced by *relational aesthetics*, biasing the outcome of relational processing towards configurations exhibiting certain fundamental symmetries, increasing their likelihood of achieving higher *S*, provided the outcome has the specified symmetry. This is a 'cost function' or 'optimization principle' embedded in the rules, guiding the computation towards elegant solutions.

4.3.1.9 *Quantum rule:*

```
Potential_Configuration_States(proto-properties) -> Resolved_Configuration_State
with Probability P(proto-properties, RuleType, local_env) upon interaction.
```

A rule governing the resolution of potential configurations (superposition) into definite ones upon interaction, introducing probabilistic outcomes reflecting the underlying uncertainty of S_0 before measurement forces a specific path of closure. This rule introduces the element of choice or non-determinism at the fundamental level.

4.3.1.10 *Economy rule:*

```
Rule Application(Configuration, proto-properties) -> Preferred Outcome
IF Outcome Maximizes S/C Ratio OR Minimizes Relational Tension
```

A rule reflecting the *economy of existence*, biasing the generative process towards outcomes that achieve the most stability (*S*) for the least complexity (*C*), or most effectively resolve relational tension, provided the outcome meets the optimization criteria. This is the cosmic drive towards efficiency and value creation.

4.3.2 *The origin of the rules:* Where do these fundamental rules come from? Are they inherent properties of distinctions and relations themselves, perhaps dictated by their proto-properties? Are they selected from a vast space of potential rules by some *meta-principle* (e.g., *relational aesthetics* applied at a higher level) that favors rules leading to coherent, complex, or self-sustaining outcomes? Are they the simplest possible set of rules that permit self-consistent computation and the emergence of structure, given the specific set of D/R proto-properties? Could they have evolved or been “learned” over immense timescales within the S_0 state before the first stable patterns emerged, a form of cosmic evolution predating the universe as we know it? This is a deep philosophical question. The autaxys framework suggests the rules must be *self-consistent*—they must not contain internal contradictions that would prevent any stable pattern from ever forming. This self-consistency requirement might severely constrain the possible rule sets, perhaps even uniquely determining them given the proto-properties. The rules *are* the logic of reality, the fundamental constraints on what can exist and how it can relate. They are the axioms of the cosmic computation, the fundamental grammar of existence. Perhaps the rules are not 'given' but are the stable, self-consistent patterns *of relation* between D and R themselves, a *meta-level* of ontological closure. The rules could be the simplest possible non-trivial set of relations that can achieve self-consistency, a form of OC at the *meta-level*? Is the Cosmic Algorithm itself a stable pattern at a higher level of abstraction, a *meta-pattern* formed from the relations *between* the fundamental D/R rules? Could the proto-properties of D and R determine the very structure of the Cosmic Algorithm? The concept of *algorithmic self-modification* adds another layer – the rules might not be static but dynamic, evolving over time based on their outcomes, guided by principles like relational tension reduction, S/C optimization, or *relational harmony* maximization. This suggests the universe is not just running a fixed program, but is actively refining its own code based on the results of its computation, a form of cosmic learning or self-optimization. This dynamic evolution of the fundamental rules would add a new layer to cosmic history, potentially leading to changes in fundamental constants or even the types of stable patterns possible over vast timescales. This self-modification could be a driver of major cosmic epochs or phase transitions. It suggests the universe has a form of computational plasticity, adapting its own logic based on its experience of generating reality. Could this process be influenced by the emergence of *higher-order patterns* (S_5+) capable of complex feedback with the underlying network? Could consciousness (S_7) play a role in influencing this self-modification?

4.4 **Interaction and combination of proto-properties**
The emergence of patterned reality from the vacuum (S_0) is driven by the dynamic interaction and combination of distinctions and relations according to the Cosmic Algorithm rules, but the *specific outcomes* are fundamentally determined by the compatibility and interaction of their inherent *proto-properties*.

4.4.1 *Proto-property compatibility:* Rules like the *formation rule* and *composition rule* explicitly include conditions based on proto-property compatibility. A distinction with a specific proto-valence and proto-polarity will only readily form a relation with a specific proto-interaction channel type if their respective proto-properties are compatible according to the rules. This compatibility is not arbitrary; it is a fundamental aspect of the Cosmic Algorithm, defining which primitives can 'bind' or 'connect' in a way that facilitates subsequent coherence. It is the universe's fundamental chemistry—which elements can form which bonds. Compatibility might be defined by simple rules (e.g., summing to zero for opposing polarities) or complex functions of multiple proto-property values. The set of possible stable patterns (*P_ID*s) and their topologies (*T*) are severely constrained by these compatibility rules.

4.4.2 *Proto-property combination in patterns:* When distinctions and relations combine to form a pattern, their proto-properties collectively influence the pattern's emergent AQNs (*C*, *T*, *S*, I_R).
4.4.2.1 The number and types of constituent primitives and the complexity of their arrangement (dictated by proto-valence and *formation/composition rules*) determine *C*.
4.2.2.2 The symmetries and asymmetries in the pattern's relational graph structure (*T*) are direct consequences of the *proto-symmetry bias* and *proto-polarity* of the constituent primitives and how they are arranged according to the rules.
4.2.2.3 The stability (*S*) of the pattern depends on the robustness of its internal *validation/closure cycle*, which is influenced by the collective *proto-coherence potential* and *proto-flow resistance* of its constituents and the efficiency with which they satisfy the *validation/closure rule*.
4.2.2.4 The pattern's *interaction rules* (I_R) are determined by how its collective proto-properties and topology (*T*) allow it to interact with other patterns according to the *composition/transformation rules*, which are constrained by the *proto-interaction channel types* and *proto-polarity* compatibility.

4.4.3 *Seeding complexity:* The inherent biases introduced by *proto-properties* are essential for seeding the emergence of complexity. Without qualitative differences and specific compatibilities between primitives, the S_0 state might remain an undifferentiated flux. Proto-properties provide the necessary 'structure' at the most fundamental level to allow for the formation of specific, ordered configurations that can then achieve *ontological closure*. They are the fundamental constraints that channel the potential of S_0 into definite, structured reality.

4.4.4 *Proto-property gradients:* The distribution and interaction of *proto-properties* could create subtle gradients or biases within the *vacuum state* (S_0) itself, influencing the local likelihood of different types of patterns emerging or different rules being applied. This contributes to the “texture” of the vacuum and could be influenced by *relational defects* or hypothetical *proto-property regulator* patterns.

4.4.5 *Initial asymmetry:* The **Big Bang** phase transition might have involved an *initial asymmetry* in the distribution, activation, or prevalence of certain *proto-properties* in the primordial S_0 state. This initial bias could have significantly influenced the subsequent evolution of the universe, potentially explaining fundamental asymmetries like the dominance of matter over antimatter (if matter/antimatter patterns are biased by specific, asymmetrically distributed proto-properties or if their formation/stability rules are asymmetric due to proto-property influence).

4.5 **(Speculative Extension) Algorithmic Self-Modification: The Universe as a Learning System**
A speculative but powerful extension of the framework suggests there could be higher-order “*meta-rules*” in the **Cosmic Algorithm** that govern how the fundamental rules themselves can be applied, combined, or even subtly modified over time. This would allow for a form of *algorithmic “evolution"* or

“learning,” where the universe's generative principles adapt based on the patterns they produce, favoring rules that lead to greater overall coherence and complexity. This would be a form of *meta-level relational aesthetics* or *economy of existence* at play, where the algorithm optimizes itself for maximal *S*/*C* generation over cosmic history. This *self-modification* could be triggered by reaching certain thresholds of complexity or *relational tension* in the network, potentially influenced by the cumulative effects of proto-property distribution. This implies the universe is not just running a fixed program, but is actively refining its own code based on the results of its computation, a form of cosmic learning or self-optimization. This dynamic evolution of the fundamental rules would add a new layer to cosmic history, potentially leading to changes in fundamental constants or even the types of stable patterns possible over vast timescales. This self-modification could be a driver of major cosmic epochs or phase transitions. It suggests the universe has a form of computational plasticity, adapting its own logic based on its experience of generating reality. This process could be influenced by the emergence of *higher-order patterns* (S_5+) capable of complex feedback with the underlying network, and potentially even consciousness (S_7).

4.5.1 *Drivers of algorithmic self-modification:*

4.5.1.1 *Relational tension feedback:* High levels of unresolved *relational tension* globally (S_{rel}) could act as a feedback signal, triggering adjustments in the rules (e.g., favoring different *formation* or *resolution rules*) that are more effective at resolving tension and increasing overall *S*. The universe learns to minimize its own logical discomfort. This mechanism is driven by the inherent drive towards minimal tension (*economy of existence*). This feedback loop could involve the average relational tension of the S_0 state (S_{rel}) influencing the probability or strength of application of rules that create or resolve tension, potentially mediated by specific proto-properties that are sensitive to tension levels.

4.5.1.2 *S/C optimization feedback:* The cumulative *S*/*C* ratio generated over time could be another metric guiding *self-modification*. Rules that produce a higher average *S*/*C* ratio in the patterns they generate are favored and become more prevalent or influential in the algorithm. The universe learns to be more ontologically efficient. This mechanism is driven by the *economy of existence* principle. The success of specific patterns (high *S*/*C*) could reinforce the rules and proto-property combinations that produced them, making them more likely to be applied in the future.

4.5.1.3 *Relational harmony feedback:* The prevalence of highly symmetrical or “aesthetically pleasing” (*relational aesthetics*) relational structures could feed back, reinforcing the *symmetry preference rule* or other rules that favor such outcomes. The universe learns to generate more beautiful structures. This mechanism is driven by the *relational aesthetics* principle. The emergence of patterns exhibiting high *relational harmony* could increase the probability or strength of rules that favor such harmony, potentially mediated by specific proto-properties that are sensitive to aesthetic configurations.

4.5.1.4 *Complexity thresholds:* Reaching certain levels of complexity (e.g., the emergence of S_4, S_5, S_6 patterns) could trigger *meta-rules* that enable new types of fundamental rules or interactions, opening up new avenues for pattern formation and evolution. The universe's capacity for learning grows with its complexity. The emergence of new *S* levels might unlock new meta-rules that allow the algorithm to explore previously inaccessible parts of the rule space.

4.5.1.5 *Influence of high-S patterns:* Patterns achieving very high *S* levels (S_5+), especially consciousness (S_7), might be able to influence the underlying relational network and rule application in subtle ways (e.g., through organized *relational resonance* or feedback loops with the vacuum texture), potentially biasing the *algorithmic self-modification* process. Conscious patterns might be able to “nudge” the Cosmic Algorithm towards outcomes that are more conducive to their own continued existence or higher *S* levels. This is highly speculative but suggests a potential feedback loop between emergent complexity and the fundamental generative principles.

4.5.2 *Mechanism of modification:*

4.5.2.1 *Rule weighting:* The influence or probability of applying different fundamental rules could change over time, with rules leading to higher *S*/*C* or greater harmony becoming statistically more likely to be applied in the D/R dynamics.

4.5.2.2 *Proto-property bias shift:* The effective prevalence or influence of certain *proto-properties* in the generative process could subtly shift, biasing the formation of patterns made from those primitives.

4.5.2.3 *Emergence of new rules:* Entirely new fundamental rules (*transformation*, *composition*, etc.) could emerge from the *meta-rules* when certain conditions are met (e.g., complexity thresholds, high tension).
4.5.2.4 *Modification of existing rules:* The parameters or conditions within existing rules (e.g., the strength parameter in a *formation rule*, the compatibility criteria in a *composition rule*) could subtly change.

5.0 The Autaxic Quantum Numbers (AQNs): Derived Properties of Stable Patterns

Stable patterns, those that achieve *ontological closure*, possess intrinsic properties determined by the specific way their internal structure satisfies OC. These properties are classified by the **Autaxic Quantum Numbers** `(Core Definition)`, serving as the fundamental axes of **the Autaxic Table**. Each AQN is a characteristic *of* a pattern that has achieved OC, and its specific value is determined by the minimal structural requirements and topological constraints imposed by the OC principle and the **Cosmic Algorithm** for that pattern type, constrained and biased by the inherent *proto-properties* of the fundamental *distinctions* and *relations* that constitute the pattern:

5.1 **P_ID (pattern identifier):** `(Core Definition)` A unique symbolic label for each distinct, stable pattern that satisfies OC. This corresponds to the identity of a fundamental particle or stable composite. It is the pattern's fundamental type or 'species' within the relational zoo, akin to a particle family or specific configuration. It represents a specific, self-validating logical structure—a “proof of existence” within the system, a stable solution to the equation of relational self-consistency. It is the emergent identity that crystallizes from the underlying relational flux, a persistent 'name' in the cosmic lexicon, a node in the phase space of stable possibilities. The *P_ID* is not assigned externally but is an intrinsic label derived from the pattern's unique combination of *C*, *T*, and *S* and its position in the phase space of stable configurations, fundamentally determined by the proto-properties of its constituent D's and R's.

5.2 **C (complexity order):** `(Core Definition)` A quantitative measure of the pattern's structural intricacy—the number of core distinctions, depth of recursion, and density of internal relational activity. This is the primary determinant of mass and energy. It can be seen as a measure of the pattern's internal 'computational state space' size, the amount of relational processing required to instantiate and maintain it, or its logical depth. *C* is a measure of the pattern's inherent 'busyness' or 'density of meaning'. It quantifies the internal relational 'work' required to uphold the pattern's ontological closure. In the *economy of existence*, *C* represents the ontological cost of the pattern, the computational resources required for its self-validation. It is the structural 'overhead' required to maintain coherence in a dynamic environment, paid in units of fundamental relational action (*h*). *C* is constrained by *T* and *S*, and fundamentally by the proto-properties of the constituent D's and R's which bias the complexity required for stable configurations. The specific value of *C* for a stable pattern is the minimal complexity required for its specific *T* to achieve a particular *S* level, driven by the *economy of existence* principle. It is the pattern's inherent 'processing load', measured by the minimal rate of D/R operations (*h* units) needed for internal self-validation.

5.3 **T (topological class):** `(Core Definition)` A qualitative classification of the pattern's internal relational graph structure—its connectivity, symmetries, and asymmetries. *T* defines the fundamental “shape” of the pattern's self-constitution, dictating *how* it achieves *ontological closure* and how it can relate to other patterns. It encapsulates the essential invariant properties of the pattern's internal network topology under deformation. *T* dictates the pattern's 'interface signature' for interactions. It is the pattern's unique structural fingerprint that determines its relational potential and its role in the cosmic grammar. *T* determines properties like charge (asymmetry), spin (rotational symmetry/flow), and particle family type (broader topological categories), all fundamentally rooted in the *proto-properties* of the D's and R's that form the pattern and the rules governing their combination. *T* captures the stable, robust features of the pattern's internal relational network that persist despite the constant flux of underlying D/R processing. It is the pattern's enduring form factor in relational space, the topological “DNA” that specifies its identity and potential interactions. *T* can be formally described using topological invariants (e.g., Betti numbers, knot invariants if relations can form knotted structures, specific group structures describing symmetries). The specific *T* configurations that are possible are

constrained by the fundamental D/R rules, the proto-properties of D and R, and the requirement of minimal *C* for stability. *T* is the blueprint for achieving ontological closure, shaped by the inherent qualities of the primitives.

5.4 **S (stability index):** `(Core Definition)` A measure of the pattern's resilience and coherence—how robustly it maintains internal *ontological closure* against potential perturbations and external interactions. *S* is determined by the specific interplay of *C* and *T* for the pattern, and the efficiency of its ontological closure mechanism. Some complex topologies (*T*) are inherently more stable (*S*) at a given complexity (*C*) than others, reflecting the elegance or robustness of their relational structure in resisting dissolution. *S* is a measure of the pattern's logical robustness or error correction capability against *relational noise*. It quantifies how 'strongly' the pattern 'wants' to exist in its current form, its resilience against ontological dissolution. In the *economy of existence*, *S* represents the existential value conferred by the pattern. It is the pattern's capacity to persist and contribute to the overall coherence of the universe. Higher *S* patterns are more “profitable” in the cosmic economy, requiring less maintenance relative to their longevity. *S* is the measure of a pattern's success in the cosmic game of self-consistent existence, fundamentally dependent on the *proto-properties* of its constituent D's and R's and how they interact according to the Cosmic Algorithm rules to achieve persistent closure. *S* could be quantified by metrics like the depth of the attractor basin in the phase space of relational configurations, the mean time to de-coherence under standard vacuum noise, or the minimum energy/relational perturbation required to break its closure. *S* is fundamentally limited by *C* and *T*; a very simple pattern (*C* low) or a highly unstable topology (*T*) cannot achieve arbitrary *S*. *S* is the achieved resilience of the OC mechanism, a direct consequence of the specific D/R configuration and their proto-properties.

5.4.1 *Types of ontological closure (S levels): mechanisms of coherence: S* is likely not a single number but represents the *mechanism* by which a pattern achieves and maintains closure, reflecting different levels of logical/computational robustness. These levels describe distinct ways a relational structure can be self-consistent and resilient. The specific mechanism is determined by the pattern's *C* and *T* and the fundamental rules it utilizes to maintain coherence. The proto-properties of the constituents likely play a role in which mechanism is available or favored.
5.4.1.1 **S_0: Undifferentiated potential / vacuum:** The baseline state of D's and R's (with their proto-properties) before stable patterns emerge. Minimal structured information, maximal potential relational flux. This is the state of pure computational possibility, a sea of unresolved relations. It is the state of maximal *relational entropy*. It is the ground state of the cosmic computation, always attempting to resolve itself into coherence. Its “mechanism” is a continuous, probabilistic exploration of relational possibilities that do not achieve persistent closure. It is the state of being 'just short' of self-consistency. Its dynamics are governed by the fundamental rules and proto-properties, embodying the inherent probabilistic nature of the ground state.
5.4.1.2 **S_1: Simple fixed point:** The pattern is a static configuration of relations that satisfies closure instantly. Such patterns might be extremely fundamental or represent transient states within the vacuum. Minimal stability, easily disrupted by any external *relational noise*. It requires continuous, but minimal, processing to exist. It is the most basic form of self-consistency, easily overwhelmed. The mechanism is a basic, non-recursive loop of relations that holds itself constant, defined by a minimal *C* and simple *T* that satisfies the *validation rule* directly, given the proto-properties. It is a static truth statement.
5.4.1.3 **S_2: Recursive structure:** The pattern's closure is achieved through self-referential loops of relations. Its stability depends on the continuous, consistent execution of this internal recursion (e.g., potentially fundamental particles like electrons or quarks *within* a composite). This is a dynamic form of stability, requiring ongoing processing. It is a stable limit cycle in relational state space. Robust against simple perturbations, but vulnerable if the recursive cycle is broken or overwhelmed. It represents stability through self-sustaining computation. It is a pattern that maintains its existence by constantly re-computing itself. The mechanism involves a feedback loop where the output of relational processing reinforces its own input, creating a stable, repeating cycle, requiring a higher *C* and specific *T* (compatible with proto-properties) to implement this recursive validation using the Cosmic Algorithm rules. It is a dynamic truth statement that validates itself through repetition.
5.4.1.4 **S_3: Dynamic equilibrium / limit cycle:** The pattern does not settle into a static or simple recursive state, but achieves closure through a stable, repeating cycle of relational transformations. Its existence is a persistent oscillation or transformation cycle (e.g., neutrinos oscillating between flavors,

representing a stable limit cycle in relational state space where transitions between subtly different *T*s maintain overall *S*). Stability depends on maintaining the cycle; disruptions can break it. It is stability through persistent change. This level embodies stability through dynamic balance. It is a pattern that maintains coherence by constantly transforming its internal state in a cycle. The mechanism involves a set of relational transformations (using *transformation rules*, constrained by proto-properties) that cycle back onto themselves, forming a stable, dynamic equilibrium, requiring a specific *T* structure that allows for these cyclic transformations while maintaining overall coherence. It is a truth statement that maintains its validity by constantly changing its form within a defined boundary.

5.4.1.5 **S_4: Composite stability:** Closure is achieved not by a single pattern but by the coherent composition of multiple patterns according to specific I_R (e.g., protons and neutrons from Quarks, atoms from nucleons/electrons). The stability (*S*) of the composite system validates the existence of its unstable or compositionally incomplete constituents within that system. This is a higher-order closure mechanism – the system achieves closure at a level above its parts. Stability is robust against perturbations to components if the overall composite structure is maintained. The whole validates the parts. This level represents stability through structured composition. The stability arises from the harmonious interplay and mutual validation of constituent patterns according to I_R (*composition rules*), constrained by proto-property compatibility. The mechanism is a network of inter-pattern relations that collectively satisfies the OC criteria, even if individual components do not, requiring compatible *T* and I_R between constituents. It is a system of mutually validating truth statements.

5.4.1.6 **S_5: Environmental meta-stability:** Patterns that achieve stability not just internally or compositely, but through continuous, dynamic interaction and feedback with a specific, stable external environment. Their closure is context-dependent (e.g., potentially complex molecules, self-replicating structures). Stability is high within the required environment, but drops significantly if the environment changes. Stability is achieved through dynamic coupling with a larger, stable pattern (the environment). This level embodies stability through contextual coherence. The pattern's existence is validated by its successful integration into a larger, stable system. The mechanism involves maintaining relational links and feedback loops (using I_R and *transformation/composition rules*, constrained by proto-properties) with an external pattern or system whose own stability reinforces the pattern's closure. It is a truth statement whose validity depends on the context of a larger truth. It requires specific I_R that allow for dynamic coupling and feedback.

5.4.1.7 **S_6: Error-correcting/adaptive closure:** Patterns with internal mechanisms to detect and correct relational inconsistencies or disruptions, actively maintaining closure through adaptation and self-repair (e.g., biological systems, potentially higher forms of organization like neural networks). High stability due to resilience and adaptability. Stability is actively maintained through internal computational processes that compensate for external noise and internal inconsistencies. This level represents stability through computational resilience. The pattern actively defends its own coherence against threats, learning and adapting its internal processes. The mechanism involves internal feedback loops that monitor for deviations from the stable structure and trigger compensating relational transformations or self-repair processes, using internal rules derived from the Cosmic Algorithm and constrained by proto-properties. It requires high *C* and complex *T* structures capable of internal monitoring and dynamic self-modification. It is a truth statement that actively defends its own validity against falsehoods.

5.4.1.8 **S_7: Self-aware/reflexive closure (consciousness):** `(Speculative Extension)` Hypothetically, patterns capable of incorporating their own process of achieving and maintaining closure into their internal structure, perhaps through internal modeling or representation (e.g., consciousness). Closure involves a feedback loop of self-validation, potentially leading to very high, robust stability. Stability is achieved by the system understanding and reinforcing its own existence. This level of closure might involve internal representations of the Cosmic Algorithm or aspects of the relational network itself. This level embodies stability through recursive self-modeling and validation, the universe becoming aware of its own process of becoming. It is a pattern that maintains coherence by reflecting upon its own process of coherence. The mechanism involves internal relational structures that model or simulate the pattern's own state and its relationship to the principles of *ontological closure* and the Cosmic Algorithm, using this internal model to reinforce its own stability. It is a truth statement that understands and asserts its own truth. It requires extremely high *C* and complex *T* structures capable of internal representation and *meta-cognition* using the rules of the *relational calculus*, enabled by specific proto-properties that allow for such complex self-referential structures. This level of

closure may also be where the organized *proto-qualia* associated with the constituent D's and R's give rise to unified subjective experience and *qualia harmonics*—the “feel” of existing and processing information, the rich, complex blend of fundamental subjective tones.
5.4.1.9 **S_8: Global/cosmic closure:** `(Speculative Extension)` Speculatively, could the entire universe as a single relational network achieve a form of global *ontological closure*? This would represent the universe as a whole achieving self-consistency across all its constituent patterns and relations. This level embodies ultimate stability, the universe as a complete, self-validating computation. It is the state where the entire relational network achieves a state of maximal, self-consistent coherence. The mechanism is the harmonious, self-consistent interplay of *all* fundamental D's and R's (with their proto-properties) and *all* stable patterns within the network, forming a single, unified, self-validating structure, governed by the Cosmic Algorithm and proto-properties, potentially influenced by *relational aesthetics* and *economy of existence*. It is the ultimate truth statement that encompasses all others.

5.4.2 *The “feel” of closure* *`(Speculative Extension)`:* A deeper speculation within *qualia harmonics* is that the very act of achieving and maintaining *ontological closure* carries an associated qualia—the fundamental “what-it's-like” of self-consistency, of “being". This basic qualia of existence would be present in all stable patterns (S_1+), increasing in richness and complexity at higher *S* levels due to the more intricate mechanisms of closure and the layered interplay of *proto-qualia*. S_7 (consciousness) would involve this fundamental qualia of existence becoming self-aware, experienced as a unified sense of “I am” or “I exist,” arising from the pattern's ability to model and reflect upon its own process of self-validation. The feeling of “rightness” or “coherence” in human experience could be a reflection of this fundamental drive towards and subjective experience of ontological closure.

5.5 I_R **(interaction rules):** `(Core Definition)` The set of logical rules defining how this pattern can coherently compose, interact with, or influence other patterns. I_R are derived from the structural compatibility constraints imposed by the patterns' respective topologies (*T*) and the overarching requirement for OC in any resulting composite pattern or interaction, governed by the Cosmic Algorithm and directly influenced by the *proto-properties* of the D's and R's involved in the interaction. These rules manifest as the fundamental forces and define the “grammar” of the cosmic language. I_R are the pattern's 'interface protocols' or 'composition grammar' for engaging with the wider relational network. They specify the valid relational transformations allowed between patterns based on their *T* and the proto-properties of the primitives involved. They are the functional 'APIs' of the patterns, defining their potential interactions in the cosmic computation. I_R define the pathways and transformations within the phase space of stable patterns. They specify which relational “sentences” can be formed using this pattern as a constituent, ensuring that any interaction maintains or increases overall coherence. I_R can be formally described using rules of composition, transformation, or graph rewriting that operate on the *T* structures of interacting patterns, ensuring that the resulting configuration satisfies OC criteria (at least transiently for force carriers or interaction states, or stably for composite patterns). I_R are constrained by the fundamental D/R rules and the principle of ontological closure; only interactions that are *logically consistent* and can lead to valid (even if transient) relational configurations are permitted. I_R are the set of allowed relational transformations a pattern can participate in, derived from its *T* and the proto-properties of its constituent primitives, and the compatibility of these with the target pattern's *T* and proto-properties according to the Cosmic Algorithm.

6.0 The Autaxic Table as a Phase Space of Possibility

The Autaxic Table is not merely a list; it represents the conceptual map of the *phase space of stable relational patterns* allowed by the fundamental rules of the universe and the principle of *ontological closure*. Each cell in this conceptual table (*P_ID*) corresponds to a specific attractor state in the dynamic system of relational processing.

6.1 **Structure of the phase space**
Imagine the table as a multi-dimensional map where the axes are the **Autaxic Quantum Numbers** (*C*, *T*, *S*, etc., potentially with sub-dimensions for specific topological invariants within *T*, or even axes representing different types of D or R if those primitives have inherent variations defined by their *proto-*

properties). Each *P_ID* is a point or region within this abstract space, representing a unique, self-consistent solution to the *ontological closure* problem. The complexity of the space is immense, potentially infinite in principle (representing all possible D/R configurations with all possible proto-property assignments), but the constraint of OC limits the *realized* points to a finite, discrete set of stable attractors. The table is a map of the stable points in the universe's computational state space, the islands of coherence in the sea of potential. The structure of this phase space is determined by the **Cosmic Algorithm**, the principle of OC, and the inherent biases introduced by the *proto-properties* of D and R. The geometry of this phase space reflects the inherent constraints and biases of the generative rules, potentially influenced by *relational aesthetics* `(Guiding Principle)`. It is the universe's landscape of logical possibility, with hills of instability and valleys of stable coherence. The distribution of stable patterns within this phase space is shaped by the *economy of existence* `(Guiding Principle)`, favoring patterns with high *S*/*C* ratios. The structure of this phase space is not fixed if *algorithmic self-modification* `(Speculative Extension)` is active; the landscape of possibility itself could subtly evolve over cosmic time, opening or closing potential attractor basins. This phase space is the universe's computational state space, where every possible configuration of D's and R's exists as a point, and the Cosmic Algorithm defines the trajectories through it, with stable patterns being the enduring destinations. It is a map of all *logically possible* self-consistent realities permitted by the underlying rules and proto-properties.

6.2 **Connectivity within the phase space**

The I_R define the “edges” or “pathways” connecting different *P_ID*s in this phase space. Particle interactions, decays, and transformations are transitions between these stable states, mediated by these defined relational pathways. These pathways are dictated by the *composition* and *transformation rules* of the **Cosmic Algorithm**, constrained by the *proto-properties* and topologies (*T*) of the patterns. The dynamics of the universe are movements within this phase space, guided by the drive towards higher *S* states and governed by the I_R. The universe traverses this landscape of possibility, following the contours of stability and interaction rules. This phase space *is* the universe's state space, and its trajectory through this space describes cosmic history. Interactions are events where the system jumps between attractor basins or moves within a complex basin. The density and nature of these connections are influenced by the proto-properties of the primitives that make up the interaction patterns (I_R carriers) and the local state of the *vacuum state* (S_0 texture) mediating the interaction. *Relational catalysis* could involve patterns that lower the “energy barrier” (the *C* cost or *relational tension*) required to transition between certain points in the phase space, increasing the rate of specific transformations or compositions.

6.3 **Gaps in the table: predicted patterns**

The “gaps” in the table, where no known particle corresponds to a derivable *P_ID*, represent predicted but unobserved stable patterns—potential new particles or phenomena waiting to be discovered. These are the empty cells in the periodic table of reality, waiting for their unique structure to be identified by the generative engine. They are the undiscovered stable solutions to the cosmic equation, the unexplored islands in the phase space. Discovering them means finding new stable attractors in the universe's state space. These gaps represent potential forms of coherence permitted by the rules and *proto-properties* but not yet observed or formed in our region of the universe. The size and distribution of these gaps are clues to the underlying Cosmic Algorithm and the specific proto-properties of D and R.

6.4 **Predictive power of the framework**

By formally defining the D/R rules, their *proto-properties*, and the closure criteria in the *relational calculus*[1], the *Autaxic Generative Engine*[2], aims to *calculate* the coordinates (*C*, *T*, *S*, I_R) of all possible stable points (*P_ID*s) in this phase space, thus filling out the table from first principles and predicting the entire spectrum of fundamental entities and their interactions. The specific values of fundamental constants would be outputs of this calculation, determined by the structure of the calculus and the proto-properties of its primitives, influenced by principles like *economy of existence* and *relational aesthetics*. This approach

allows for the prediction of not just new particles, but also their fundamental properties and interaction modalities, based on their predicted position in the phase space.

6.5 **Conceptual comparison table: Standard Model vs. hypothetical autaxic patterns**

To facilitate understanding and comparison, Table 6.5.1 provides a conceptual overview of how known Standard Model particles and hypothetical novel *autaxic patterns* might be classified according to their **Autaxic Quantum Numbers** (AQNs). It is important to note that the values presented here are conceptual and qualitative, pending rigorous derivation from a formalized *relational calculus*.

Table 6.5.1: Conceptual Autaxic Classification of Known and Hypothetical Patterns

Pattern Name (P_ID)	**Potential Standard Model Analogue**	**Conceptual C (Complexity)**	**Conceptual T (Topology)**	**Conceptual S (Stability)**	**Conceptual I_R (Interaction Rules)**	**Hypothesized Generative Origin**
Electron	Electron	Moderate	Spinor, asymmetric	High (S_2)	EM, weak, gravity	**T:** Asymmetry from *proto-polarity* -> charge. **S:** Simple recursive loop -> S_2 stability.
Photon	Photon	Minimal (≈0)	Vector, propagating	Transient (S≈0)	EM	**C:** A transient R pattern with no stable D structure, giving C≈0. Pure relational propagation.
Up quark	Up quark	Moderate	Spinor, asymmetric	Very low (isolated)	Strong, weak, EM, gravity	**S/T:** Incomplete topology, cannot achieve OC alone; requires S_4 composite closure.
Down quark	Down quark	Moderate	Spinor, asymmetric	Very low (isolated)	Strong, weak, EM, gravity	**S/T:** Incomplete topology, cannot achieve OC alone; requires S_4 composite closure.
Gluon	Gluon	Low	Vector, confining	Transient (S≈0)	Strong	**I_R:** Embodies the composition rule for S_4 quark structures, mediating the strong interaction.
W boson	W boson	High	Vector, charged	Transient	Weak, EM, gravity	**I_R:** High-C pattern embodying a specific, asymmetric transformation rule between T-classes.
Z boson	Z boson	High	Vector, neutral	Transient	Weak, EM, gravity	**I_R:** High-C pattern embodying a specific, symmetric transformation rule between T-classes.
Higgs boson	Higgs boson	Very high	Scalar, symmetric	Very low	Higgs coupling, gravity	**C/I_R:** High-C pattern whose I_R mediates the expression of

Pattern Name (P_ID)	Potential Standard Model Analogue	Conceptual C (Complexity)	Conceptual T (Topology)	Conceptual S (Stability)	Conceptual I_R (Interaction Rules)	Hypothesized Generative Origin
						other patterns' C as inertia.
Neutrino (e, μ, τ)	Neutrino	Very low	Spinor, cyclical	High (S_3)	Weak, gravity	**S:** Achieves stability via a dynamic equilibrium cycle between three distinct but related T-states.
Graviton	Graviton (hypothetical)	Variable (emergent)	Tensor (emergent)	High (emergent)	Gravity (emergent)	**(Not a P_ID)** An emergent property of network geometry, not a fundamental pattern.
Hypothetical Novel Patterns						
P_{auton}	Dark matter candidate	Very high	Complex, non-scalar	Extremely high (S_5/S_6/S_7)	Gravity, catalytic closure	**S/C/T:** A high-C/T solution to OC using an advanced S-level mechanism (e.g., S_6).
$P_{chronon}$	Cosmic pacemaker candidate	Very low	Cyclical/toroidal	High (S_3)	Tempo coupling, gravity	**T/S:** A stable (S_3) toroidal T-class of pure relational flow, influencing local processing speed.
$P_{structuron}$	Topological dark matter candidate	Moderate	Lattice-like, crystalline	High (S_4/S_5)	Structural embedding, gravity	**T/I_R:** A T-class whose I_R favors forming rigid, stable composite structures (S_4+) in spacetime.
$P_{logicon}$	Fundamental logic gate	Very low	Logical, directional	Very low (transient)	Rule embodiment	**(Not a P_ID)** The transient physical embodiment of a Cosmic Algorithm rule being executed.
$P_{aestheticon}$	Cosmic harmony bias	Minimal	Symmetric, coherent	Moderate (S_2/S_3)	Coherence resonance	**T/S:** A simple, symmetric T-class that promotes coherence in nearby S_0 fluctuations.
P_{darkon}	Dark energy candidate	Zero	Diffuse, non-local	Maximal (S_0/S_1)	Network tension	**(Not a P_ID)** The inherent relational tension property of the S_0 vacuum state itself.

7.0 The Life Cycle of an Autaxic Pattern

Autaxys views particles not as eternal billiard balls, but as dynamic processes with a life cycle within the relational network:

7.1 **Emergence from vacuum (birth)—relational actualization**

A pattern arises from the background relational activity of the *vacuum state* (S_0) when a configuration of D's and R's (with specific *proto-properties*) locally satisfies the conditions for *ontological closure*, achieving a stable state (S_1 or higher). This is a phase transition from potentiality to actuality, a local crystallization of coherence from the sea of possibility, a computational “bootstrapping” into a self-validating state. It is the spontaneous formation of a *logically self-consistent* structure from the raw computational substrate, guided by the *formation rules* and proto-property compatibility. The probability of emergence might be related to the prevalence of the necessary D/R configurations with compatible proto-properties in the vacuum fluctuations (S_0) and the “depth” of the resulting stable attractor in the phase space (*S*). Emergence is the universe locally finding a stable solution to the OC problem. The specific proto-properties of the D's and R's involved in the fluctuation bias the type of pattern (*P_ID*, *T*) that can actualize. This process is *relational actualization*—the transformation of potential relations into actual, stable relational structures. It is the universe locally fulfilling its logical possibilities, driven by the inherent dynamics of S_0 and the constraints/biases of the **Cosmic Algorithm** and proto-properties. It is the transition from the probabilistic realm of the *quantum relational foam* to the deterministic persistence of a stable pattern.

7.2 **Persistence (life)**

The pattern maintains its existence by continuously performing the internal relational processing required for its specific form of *ontological closure* (*S*), according to the *validation rule*. This internal activity is its structural inertia (*C*). Its *interaction rules* (I_R) govern its engagement with the external relational network. It is a self-sustaining computation running its internal validation cycle, an island of stability in the dynamic network. The pattern actively resists dissolution by constantly re-affirming its own coherent structure through internal relational work, which is the execution of its internal logic using the Cosmic Algorithm rules, influenced by the proto-properties of its constituents. Its persistence is a continuous act of self-creation and validation. The rate of this internal processing is related to *C* and contributes to *E*. The specific dynamics of this persistence are dictated by the pattern's internal *T* and *C*, and the underlying rules of the *relational calculus*, influenced by the proto-properties of its constituents. The pattern's stability (*S*) is a measure of the resilience of this internal process against the disruptive influence of *relational noise* from S_0. Higher *S* patterns are more robust against this noise.

7.3 **Interaction (engagement)**

Patterns interact by forming temporary, higher-order relational structures according to their compatible I_R. This can involve exchanging relational activity (forces), forming composite patterns, or triggering transformations. Interactions are moments of shared computation seeking higher-level or transient closure, where the I_R act as protocols for merging or transforming relational states, using the *composition* and *transformation rules* of the **Cosmic Algorithm**, constrained by proto-property compatibility. They are the universe's way of building complexity and dynamics through pattern communication and combination. Interactions are dynamic events in the phase space, moving patterns along defined trajectories. Interactions are the universe's way of exploring compositional possibilities and building larger, more complex relational structures. The specific I_R are constrained by the *T* and proto-properties of the interacting patterns. Force carriers are the transient patterns that embody the interaction rules being executed. Interactions are the means by which patterns influence each other's state and trajectory in the phase space, potentially leading to transitions to different attractor basins.

7.4 **Transformation (change)**

A pattern can change its state (e.g., gaining/losing energy, changing momentum) or identity (decaying, reacting) through interactions that alter its internal relational structure or cause it to transition to a different, more stable *P_ID* state within the phase space, following defined I_R pathways. These are state transitions within the phase space, driven by relational dynamics and the drive towards higher *S*, governed by the *transformation* and *resolution rules* of the **Cosmic Algorithm**, triggered by interactions defined by I_R and constrained by proto-property compatibility. Transformations are the allowed “moves” within the cosmic grammar, leading from one stable pattern configuration to another. These transitions are governed by energy/momentum conservation

(conservation of relational activity *C*) and the drive towards increased stability *S* (*economy of existence*). The probability and nature of the transformation are dictated by the specific I_R, the relative *S* of the initial and final states, and the probabilistic nature of the *quantum rule*, influenced by proto-properties.

7.5 **Decay/dissipation (end)**
A pattern with insufficient *S* or one destabilized by interaction loses its ability to maintain *ontological closure*. Its internal relations become incoherent, and it resolves into simpler patterns with higher *S* (decay) or dissipates back into the background relational activity of the *vacuum state* (S_0), according to the *resolution/cancellation rules*. This is the computation halting in an unstable state, its structure dissolving back into potential, its logical coherence lost. It is the return of structured information to the sea of potential, driven by the principle of seeking greater stability and the *economy of existence*. Decay is the universe pruning unstable computations, resolving *relational tension* into more stable forms. The specific decay products and rates are determined by the pattern's *S*, *C*, *T*, its I_R with potential decay products and the vacuum, and the probabilistic outcomes dictated by the *quantum rule* and the proto-properties of the resulting D's and R's.

8.0 The Autaxic Vacuum (S_0): The Ground State of Relational Potential

The “vacuum” is the ground state of the relational network – the minimal configuration of D's and R's existing even without stable patterns. It is the domain of potential relations and transient fluctuations, the sea of unresolved processing.

8.1 **Nature of S_0: the quantum relational foam**
S_0 is a vast, interconnected, and rapidly fluctuating graph of D's and R's (with their *proto-properties*). It is a state of maximal potential relational activity and minimal persistent structure. Think of it as a seething sea of potential connections and differentiations, a continuous attempt by the **Cosmic Algorithm** to form relations that do not (yet) achieve stable *ontological closure*. It is the source of all transient fluctuations and virtual patterns. It embodies the universe's pure capacity for *relation* and *distinction* before these crystallize into enduring forms. It is the state of maximal *relational tension* waiting to be resolved into stable coherence. The state of S_0 is defined by the fundamental D/R rules and their inherent dynamics, representing the lowest energy/complexity configuration that still maintains the potential for relation and distinction, influenced by the proto-properties of its constituents.

8.2 **The texture of S_0**
At the Planck scale, this relational network has a specific microstructure or “texture” determined by the fundamental D/R rules and the *proto-properties* of D and R. This is not smooth spacetime, but a dynamic, potentially discrete, and probabilistic graph. The properties of this texture (e.g., average connectivity density, types of transient R's that are momentarily favored based on proto-types, inherent biases in D/R formation/transformation due to proto-properties, the prevalence of specific minimal D/R configurations) directly influence the likelihood and nature of stable pattern emergence (S_1 from S_0) and interaction (I_R). The “grain” of the vacuum is the fundamental granularity of reality at its deepest level, the computational lattice upon which all emergent phenomena are built. This texture could be non-uniform, potentially exhibiting subtle large-scale biases or even *relational defects* from the early universe phase transition. The texture is a manifestation of the Cosmic Algorithm in its ground state, the dynamic fingerprint of the fundamental rules in action before stable patterns emerge. It is the arena where the probabilistic aspects of the *quantum rule* are most evident. The proto-properties of D and R are crucial in shaping this texture, biasing the types of connections and distinctions that are most likely to fleetingly form in the vacuum, giving S_0 its specific characteristics. It is the fundamental 'nothingness' from which 'somethingness' (distinctions and relations) emerges, and into which it dissolves.

8.3 **Relational noise**
The constant, unclosed flux of D's and R's in S_0 constitutes fundamental *relational noise*. This is the inherent background uncertainty and unpredictability in

the relational network. This noise can perturb the internal dynamics of stable patterns, influencing their stability (*S*) and potentially triggering decay or forcing resolution from superposition. It is the fundamental 'static' in the cosmic computation, the inherent deviation from perfect coherence. The level and nature of this noise are determined by the dynamics of S_0, which are governed by the Cosmic Algorithm and the proto-properties of D and R. This noise is the source of spontaneous vacuum fluctuations and contributes to decoherence in quantum systems. It is the fundamental 'cost' of maintaining a dynamic potentiality—the inherent instability of the ground state before structured coherence emerges.

8.4 **Relational tension**

The vacuum (S_0) can be seen as a state of high *potential relational tension*—a vast number of unfulfilled or inconsistent relational possibilities. The formation of stable patterns (*P_ID*) is a process of locally *resolving* this tension by achieving coherence. The drive towards higher *S* is the universe's tendency to minimize total relational tension by creating more stable, self-consistent structures. Unstable patterns represent unresolved tension that eventually forces them to decay. The universe seeks to reduce overall *logical inconsistency* by forming stable, coherent structures. This tension is the driving force behind the generative process, the universe's intrinsic motivation to find coherent solutions. It is the universe's fundamental 'discomfort' with incoherence. *Relational defects* represent localized, stable regions of persistent relational tension within S_0. The drive towards minimal tension is a form of *cosmic optimization*, a principle of least action applied to *logical consistency*. This principle is potentially influenced by the proto-properties of D and R, as some combinations might inherently create more tension than others.

8.5 **Zero-point energy**

The minimal, irreducible relational activity inherent in S_0 is the *zero-point energy*. It is the constant background processing load of the vacuum network, the energy required to maintain the potential for D's and R's and their dynamic interaction, influenced by the *proto-properties*. This energy fuels vacuum fluctuations and mediates interactions, acting as the baseline computational activity of the universe. It is the “cost” of potentiality, the restless energy of the logical ground state. This persistent activity could be related to dark energy, driving the large-scale dynamics of the emergent spacetime network by influencing the *propagation rules* (*c*) or the cost of relational action (*h*) across vast distances. It represents the 'noise' or 'background processing' of the cosmic computation, the base level of *relational tension* that has not been resolved into stable patterns. It is the fuel source for spontaneous pattern emergence and interaction mediation. The zero-point energy is the minimum relational activity required to maintain the computational substrate itself, the “cost of potentiality". It is the restless energy of pure possibility. The level of zero-point energy is likely determined by the specific D/R rules and the proto-properties of D and R, defining the minimum level of activity required to sustain the fundamental relational network itself.

8.6 **Virtual patterns (virtual particles)**

Virtual patterns are transient configurations of D's and R's (with their *proto-properties*) that momentarily achieve minimal, unstable closure ($S \approx 0$) within S_0. They represent fleeting computational attempts or localized coherences that quickly dissolve back into the background flux, according to the *resolution/cancellation rules*. They mediate I_R between stable patterns by providing temporary relational bridges or executing brief logical operations before dissipating. They are the ripples on the surface of the vacuum sea, the momentary crystallizations of potential relations that do not achieve lasting form but facilitate interaction between those that do. They embody the fleeting, probabilistic nature of the vacuum state. They are 'failed computations' or 'transient proofs of concept' in the vacuum's search for closure, mediating interactions without achieving lasting existence. Their properties (e.g., virtual mass, lifetime) are governed by the rules of S_0 dynamics, the proto-properties of their constituents, and the specific I_R they are mediating.

8.7 **Relational fields**

The *autaxys* framework can reinterpret the concept of physical fields (e.g., the electromagnetic field, gravitational field, Higgs field) as emergent properties of the relational network or collective behavior of patterns. A *relational field* is not a fundamental entity but a description of the collective state, biases, or

potential for interaction within a region of the relational network. This state is determined by the local density and types of D's and R's (with their *proto-properties*), the presence and properties (*T*, *C*, *S*) of stable patterns, and the influence of *relational defects*. A charged pattern creates a bias in the surrounding vacuum texture (S_0) via its I_R and the *propagation rules*, making it more likely for certain types of transient R's (with specific proto-types) to form or propagate in its vicinity—this is the electromagnetic field. A massive pattern deforms the network geometry, altering propagation rules—this is the gravitational field. The Higgs field is a description of the vacuum state's interaction potential with high-*C* patterns. Relational fields influence the local application of the **Cosmic Algorithm** rules. The “strength” of a field at a point describes how strongly it biases the formation, transformation, or propagation of D's and R's (with specific proto-properties) at that location. They are the emergent forces or influences that guide the dynamics of the fundamental primitives and patterns within a region. They are the macroscopic manifestation of underlying biases in the relational network.

9.0 Relational Thermodynamics: Entropy, Temperature, and the Drive for Coherence

The concepts of thermodynamics are not just macroscopic descriptions but have roots in the fundamental dynamics of relational processing and the microstructure of the vacuum.

9.1 **Relational entropy (S_{rel})**
Relational entropy (S_{rel}) is reinterpreted as a measure of the degree of *unresolved relational tension* or *disorder* in the relational network. S_0 represents a state of high potential relational tension and maximal relational entropy ($S_{rel,max}$) because it contains a vast number of unclosed, fluctuating relations. The formation of stable patterns (S_1+), *relational defects* (S_{defect}), and *higher-order composite structures* (S_4+) represents a local *decrease* in relational entropy, as potential tension is resolved into coherent, self-consistent configurations. The drive towards higher *S* levels is fundamentally a drive towards states of lower relational entropy and greater local order/coherence. Macroscopic entropy in classical thermodynamics is the cumulative effect of unresolved relational tension and disordered relational configurations at lower levels. It is the measure of the universe's computational “waste” or unresolved potential. The Second Law of Thermodynamics is the drive towards minimizing global relational tension, but the process of achieving local coherence (forming patterns) often dissipates some relational activity into unstructured S_0 fluctuations, increasing the overall S_{rel} of the vacuum. It reflects the inherent inefficiency of converting unstructured relational potential into perfectly structured coherence.

9.2 **Relational temperature (T_{rel})**
Relational temperature (T_{rel}) is a measure of the *intensity* and *frequency* of relational fluctuations and unresolved processing within a region of the network, particularly in the vacuum (S_0). High T_{rel} corresponds to a highly active, turbulent vacuum state with rapid, energetic fluctuations (high *C* in transient patterns). Low T_{rel} corresponds to a quieter, less active vacuum state. T_{rel} influences the rate of pattern formation (S_1 from S_0), decay (lower *S* patterns are less stable in a high T_{rel} environment), and interaction rates (I_R). The early universe was a state of very high T_{rel} (intense S_0 activity), favoring rapid pattern formation and transformation. As the universe expanded and cooled (T_{rel} decreased), the S_0 activity lessened, allowing more stable patterns to persist and composite structures to form. T_{rel} is the “heat” of the relational network, the intensity of its fundamental processing noise. It is the average energy of the transient relational activity in the vacuum, which is governed by the dynamics of D's and R's (and their *proto-properties*) and the Cosmic Algorithm rules in S_0. It is the temperature of the computational substrate.

9.3 **Relational work and heat**
Relational work is the process of transforming relational configurations to achieve or maintain *ontological closure*, mediated by the application of the **Cosmic Algorithm** rules and the expenditure of relational action (*h*). *Relational heat* is the transfer of unstructured relational activity (S_0 fluctuations) between systems, increasing their internal *relational tension* or energy without necessarily increasing their structured coherence. The Second Law of

Thermodynamics, stating that entropy (S_{rel}) tends to increase in a closed system, reflects the fundamental drive of the universe's computation towards states of minimal relational tension and maximal coherence, but where some relational activity is always dissipated as unstructured heat (S_0 fluctuations) during transformations, increasing the overall S_{rel} of the vacuum background. It reflects the inherent inefficiency of converting unstructured relational potential into perfectly structured actual, a form of fundamental computational heat loss.

9.4 **Arrow of time (emergent)**
The thermodynamic arrow of time (entropy increase) is deeply linked to the drive towards higher *S* (stability/coherence) and the resolution of *relational tension*. While local regions can decrease S_{rel} by forming stable patterns, the process of transformation and interaction always generates some degree of unstructured relational activity (heat) that increases the overall S_{rel} of the vacuum. The universe evolves towards a state of maximal overall coherence (high total *S*) but also towards a state where the remaining unstructured relational activity (S_0) is uniformly distributed as low-intensity vacuum fluctuations (maximal total S_{rel}, minimal T_{rel}). Time flows in the direction of increasing overall *S* and S_{rel}.

10.0 Relational Actualization: Crystallization from Potential

The transition from the *vacuum state* (S_0)—the realm of maximal potentiality and unstructured relational flux—to the emergence of stable patterns (S_1+) is a process of *relational actualization*. It is the universe locally fulfilling its logical possibilities by achieving *ontological closure*.

10.1 **The spark of distinction**
The process begins with the inherent dynamics of the S_0 state, driven by the **Cosmic Algorithm** and the *proto-properties* of D and R. Fluctuations constantly arise, forming transient configurations of D's and R's. These fluctuations are the universe exploring the vast space of possible relations, biased by the proto-properties (e.g., *proto-polarity* favors certain connections, *proto-coherence potential* biases towards certain groupings).

10.2 **Momentary coherence**
When a local fluctuation happens to form a configuration of D's and R's (with compatible *proto-properties*) that *momentarily* satisfies the basic criteria for *ontological closure*, even minimally (S_1 potential), it becomes a potential pattern. This requires the local relational structure to be self-consistent according to the *validation/closure rule*. This is a fleeting moment of local coherence in the S_0 flux. The probability of this occurring is governed by the *quantum rule* and the local texture of S_0 (influenced by proto-properties).

10.3 **Self-reinforcement and attractor capture**
If this momentary coherence is sufficiently robust (high enough initial *S* potential) and the local *relational noise* is not overwhelming, the pattern's internal dynamics can begin to self-reinforce, drawing in nearby compatible D's and R's from the vacuum and solidifying its structure. This is the pattern “capturing” the local relational flow and potential, pulling it into its own self-validating cycle. It is like a tiny vortex forming in the sea of potential, drawing in the surrounding water to sustain itself. This process is driven by the inherent tendency towards minimal *relational tension* and the *economy of existence* `(Guiding Principle)` (favoring higher *S*/*C*). The pattern enters an attractor basin in the phase space of relational configurations. The specific proto-properties of the D's and R's in the initial fluctuation and the surrounding S_0 bias which type of pattern (*P_ID*, *T*) actualizes.

10.4 **Crystallization and persistence**
As the pattern self-reinforces, it “crystallizes” from the S_0 state, establishing a stable, self-sustaining relational structure with defined AQNs. It has successfully actualized a specific logical possibility for coherent existence. Its persistence depends on its ability to continuously maintain this closure against

relational noise and perturbations, using its internal processing (driven by *C*, dictated by *T*, measured by *S*). This is the pattern actively re-computing itself into existence, consuming relational action (*h*) in its internal *validation/closure cycle*.

10.5 **Relational potential vs. actual**

S_0 is the realm of pure *relational potentiality*. It has the *capacity* to form any possible *relation* or *distinction*. Stable patterns are regions where this potentiality has been *actualized* into definite, structured, self-consistent forms. The universe's evolution is the ongoing process of actualizing potential into stable reality, driven by the **Cosmic Algorithm** and the principle of *ontological closure*, guided by *relational aesthetics* and *economy of existence* `(Guiding Principles)`, and shaped by the inherent biases (*proto-properties*) of the primitives. The arrow of time is the direction of this actualization process, from less structured potential towards more structured actual reality.

11.0 The Grammar of Interaction (I_R): The Language of the Cosmos

The *interaction rules* (I_R) are not just a list of permitted couplings; they constitute the *formal language or grammar by which patterns can coherently relate, compose, and transform*, governed by the **Cosmic Algorithm**. They are derived directly from the topological compatibility (*T*) of the patterns involved and the overarching requirement for OC in any resulting interaction or composite, heavily influenced by the *proto-properties* of the D's and R's constituting the patterns and involved in the interaction.

11.1 I_R **as relational syntax**

I_R define the valid sequences, combinations, and transformations of patterns. They are the “verbs” and “sentence structures” that can be formed using *P_ID*s as “nouns,” ensuring that the resulting composite patterns or interactions are *logically consistent* and capable of achieving at least transient *ontological closure*. For example, an I_R might state that a pattern *P_A* with topology *T_A* (built from D's/R's with proto-properties) can compose with *P_B* with *T_B* (built from D's/R's with proto-properties) *only if* the resulting structure $T_{composite}$(*T_A*, *T_B*) satisfies the minimum criteria for ontological closure (S_4), and the proto-properties of the D's and R's at the interface are compatible according to the *composition rules*. I_R are the rules for how patterns can form valid relational “sentences” in the cosmic language. They are the rules of *logical composition* and *transformation* for stable patterns. They define the allowed operations in the cosmic computation at the pattern level. They are influenced by the local S_0 texture and the presence of other patterns.

11.2 **Force carriers as grammatical operators**

Force-carrying patterns (e.g., photons, gluons, W/Z bosons) are the physical manifestations of these grammatical rules being applied. A photon is the pattern that represents the successful “electromagnetic relation” operation between two charged patterns (*T*s with specific asymmetry and D's with compatible *proto-polarity*). A gluon represents the “strong color composition” rule between quarks (*T*s with specific color topology and D's/R's with compatible *proto-type*). The exchange of a force carrier *is* the execution of a specific *interaction rule*, a transient pattern whose closure is validated by being successfully 'parsed' or 'integrated' by the receiving pattern. They are the 'function calls' or 'messages' that enable relational transformations. They are the dynamic elements that facilitate the building of more complex relational structures or the transformation of existing ones, according to the grammar. They are the “communication packets” of the relational network, carrying the instructions for how patterns should relate. They are the physical embodiment of the relational operators defined by the I_R. The specific properties of force carriers (mass, spin, range) are determined by their *C*, *T*, and *S*, which are derived from the minimal D/R configuration and proto-properties required to embody that specific interaction rule.

11.3 **The hierarchy of grammars**

Different sets of I_R define different fundamental “grammars"—the strong, weak, electromagnetic, and potentially other interaction types. These grammars are

likely related to fundamental types of R (relations) at the deepest level (*proto-properties* of R), or different classes of topological compatibility rules (*T*) that are favored by the proto-properties of the D's and R's involved. The strength of a force could relate to the 'frequency' or 'ease' with which patterns can satisfy the rules of that grammar, or the 'computational cost' (*C* of the force carrier) of executing the rule, or the underlying “valence compatibility” defined by the proto-properties. Different forces represent different fundamental ways patterns can relate and compose to form coherent structures, each governed by its own set of grammatical rules determined by the Cosmic Algorithm and the proto-properties of D/R. The Standard Model forces are the emergent grammars of the universe's language of interaction.

11.4 **Forbidden interactions**
Interactions that violate I_R are “ungrammatical” or “logically inconsistent” and cannot occur as stable phenomena. They would correspond to attempts to form configurations of D's and R's (with their *proto-properties*) that cannot achieve even transient *ontological closure* according to the fundamental rules. This explains why certain particle reactions or decays are forbidden—they represent sequences of relational transformations that are not permitted by the cosmic grammar. They are syntactically incorrect relational operations, computational states that cannot reach a valid halting point. They are *logical contradictions* in the language of interaction, often due to incompatible proto-properties or topological mismatches.

11.5 **The 'lexicon' of *P_ID*s**
The Autaxic Table of Patterns (*P_ID*s) forms the fundamental “lexicon” of the cosmic language—the set of stable, self-validating 'words' that can be used to construct the universe's narrative through interactions and compositions.

11.6 **(Speculative Extension) The dynamics of language evolution**
Could the **Cosmic Algorithm** allow for subtle “evolution” or “learning” in the fundamental rules or I_R over cosmological timescales? `(Speculative Extension)` This possibility of *algorithmic self-modification* suggests a universe whose fundamental “language” is not fixed but dynamic. Perhaps the rules are not static axioms but dynamic principles that adapt based on the patterns they produce, favoring rules that lead to greater overall coherence and complexity in the long run, influenced by the *economy of existence* and *relational aesthetics*. This would imply a universe that is not just running a fixed program, but is actively refining its own code. This could be linked to the proto-properties of D and R themselves having a dynamic aspect or evolving capacity, or to the influence of *higher-order patterns* (S_5+) on the application or weighting of the fundamental rules.

12.0 Relational Topology and Emergent Geometry

The pattern's *topological class* (*T*) is not just an internal descriptor; it plays a fundamental role in shaping the emergent geometry of spacetime. The universe's geometry is a large-scale consequence of the distribution and types of relational structures (*T*) that inhabit it.

12.1 **Geometry as emergent structure**
The geometric properties of space (e.g., distance, curvature, connectivity) are not pre-existing but emerge from the structure and dynamics of the relational network formed by D's and R's and stable patterns. The density and connectivity of relations, influenced by the presence of patterns (especially high-*C* patterns), define the local “shape” of this network.

12.2 **Topology's role in geometry**
The internal topology (*T*) of stable patterns influences the local geometry of the emergent network in two key ways:

12.2.1 *Local network deformation (gravity):* High-*C* patterns, being dense knots of relational activity, locally increase the density of D's and R's and alter their connectivity patterns around the pattern. This local change in relational structure directly deforms the emergent geometry, which is perceived as gravity. The *type* of deformation is influenced by the pattern's *T* and the *proto-properties* of its constituents, as different *T*s might distribute *relational tension* or activity differently. For example, a pattern with a specific topological asymmetry (*T* linked to charge, rooted in *proto-polarity*) might induce different local relational biases in the vacuum than a symmetric pattern (*T* linked to spin-0).
12.2.2 *Imposing relational structure:* The I_R derived from a pattern's *T* dictate how it connects to other patterns. These connections are new edges in the emergent relational graph. The collective effect of many patterns forming relations according to their I_R builds the large-scale structure and connectivity of the spacetime network. The *type* of connections formed (e.g., specific R *proto-types*) influences the local geometry and topology of the emergent space. For instance, patterns with I_R that favor forming rigid, lattice-like connections (like the hypothetical *structuron*) could introduce local regions of increased structural order or preferred directional pathways in spacetime, based on the proto-properties of the D's and R's involved in these connections.

12.3 **Emergent dimensions**
The apparent 3+1 dimensions of spacetime could emerge from the *minimal number of degrees of freedom or relational connections required to uniquely specify the position and state of a distinction (D) or pattern within the evolving relational network*, given the constraints imposed by the **Cosmic Algorithm** and the *proto-properties* of D and R. If the fundamental rules and proto-properties naturally favor the formation of local relational neighborhoods where each D must maintain coherent relations with at least four other D's to achieve minimal stability (S_1), this could bias the network towards a structure that locally resembles a 4-dimensional lattice or graph. The perceived “flatness” of spacetime could be the emergent large-scale behavior of a highly connected, locally regular relational graph, where the density and types of connections are globally consistent on average, due to the prevalence of certain pattern types and S_0 dynamics governed by proto-properties. Higher relational dimensions could exist as latent topological or computational degrees of freedom in the underlying D/R graph that do not manifest macroscopically, perhaps related to the number of distinct proto-property types or the complexity of relational connections allowed by the rules. The dimensionality of spacetime might be a consequence of the most “economically efficient” or “aesthetically pleasing” way to achieve stable, propagating relational structures given the specific set of proto-properties of D and R.

12.4 **Dynamic geometry (gravitational waves)**
Since patterns can change state, interact, form composites, and decay, the underlying relational network is constantly being restructured. This means emergent geometry is not static but dynamic. Gravitational waves are propagating disturbances in this dynamic relational network geometry, caused by accelerating high-*C* patterns altering the local processing rate (*c*) and connectivity structure, as described by the *propagation rules*, influenced by proto-properties.

12.5 **Non-Euclidean geometry**
The possibility of Non-Euclidean Geometry (curvature) arises naturally if the distribution of patterns (mass/energy density) is non-uniform, causing local variations in the density and connectivity of the relational network. The presence of *relational defects* could also introduce persistent Non-Euclidean features or topological anomalies into the emergent geometry.

12.6 **Relational distance**
Distance in emergent spacetime is fundamentally a measure of the *relational path length* between patterns—the number of fundamental D/R processing steps (*h*) or relational 'hops' required to propagate influence or information through the network, weighted by the “cost” or “resistance” of the relations along the path (influenced by R *proto-properties* and local *C*/*S* density). Geodesics (paths of shortest distance) are the paths of greatest relational efficiency or

lowest computational cost through the network. Gravity warps spacetime by altering the cost and connectivity of relational paths, making paths towards high-*C* regions relationally “shorter".

12.7 **Topology of spacetime**
The large-scale topology of spacetime (e.g., whether it is simply connected, has holes, is infinite) is determined by the global structure and connectivity of the entire relational network. *Relational defects* could manifest as topological features of emergent spacetime (e.g., *cosmic strings* as *line defects*, *domain walls* as *surface defects*).

13.0 Towards a Formal Basis: The Relational Calculus

While the full formalism is a future project, the underlying principles suggest potential mathematical frameworks that can model relational structures, dynamics, and self-consistency. The goal is a formalism where the rules of composition and transformation within this mathematical structure inherently generate the set of stable patterns (*P_ID*s) with their properties (*C*, *T*, *S*, I_R), rather than these being input parameters. The fundamental rules should be minimal and self-consistent, and the complexity of the universe should arise spontaneously from their iterative application under the constraint of *ontological closure*, guided by *proto-properties* and potential optimization principles. This mathematical structure *is* the universe at its most fundamental level. The search for the fundamental rules is the search for the most elegant, self-generating mathematical structure, the most fertile logical grammar, constrained by the inherent nature (*proto-properties*) of its primitives.

13.1 **The need for a relational calculus**
To move beyond conceptual description, *autaxys* requires a formal mathematical framework—a *relational calculus*—that can precisely describe the fundamental primitives, their *proto-properties*, and the rules of the **Cosmic Algorithm**. This calculus would be the language in which the universe computes its existence.

13.2 **Core components of the calculus**
A *relational calculus* would need:
13.2.1 A formal definition of *distinctions* (D) and *relations* (R) as mathematical objects or fundamental types.
13.2.2 A system for representing and classifying *proto-properties* associated with D and R (e.g., as labels, attributes, or sub-types). How are proto-properties formally encoded and how do they constrain rule application?
13.2.3 A set of formal *operators* or *functions* that represent the fundamental rules of the **Cosmic Algorithm** (e.g., *genesis*, *formation*, *transformation*, *composition*, *resolution/cancellation*, *propagation*, *validation/closure*). How do these operators handle proto-properties?
13.2.4 A mechanism for expressing *ontological closure* as a formal property or condition within the calculus (e.g., a fixed point, a self-referential loop, a specific proof structure, a stable attractor in a dynamical system defined by the calculus). How is the *S* level formally derived from the structure and dynamics within the calculus?
13.2.5 A way to derive or assign **Autaxic Quantum Numbers** (AQNs) (*C*, *T*, *S*, I_R) to structures that satisfy the OC condition within the calculus. *T* might be related to topological invariants of the formal structure, *C* to its complexity (e.g., number of primitives, depth of recursion), *S* to its robustness against perturbations by the calculus's operators, and I_R to the allowed applications of the calculus's composition/transformation operators involving this structure, constrained by proto-properties. Can these AQNs be formally derived as outputs of the calculus for any given stable structure?
13.2.6 A mechanism for incorporating *probabilistic elements* (*quantum rule*) into the application of rules or the resolution of states, potentially influenced by proto-properties. Can probabilities be derived from the structure of the calculus itself (e.g., counting valid paths in a state space, statistical properties of rule

application)?
13.2.7 Formal expressions of guiding principles like *relational aesthetics* and the *economy of existence* within the calculus, potentially as optimization criteria or biases influencing the application of other rules. Can “elegance” or “efficiency” be formally quantified in terms of the calculus's operations or structures?

13.3 **Nature of the calculus (speculative frameworks):** This calculus could draw inspiration from various mathematical fields, but it would need to be inherently dynamic, expressive of concurrency and distributed processes, and capable of self-reference and self-generation. It might be a form of:
13.3.1 *Stochastic process calculus:* Incorporating inherent probabilistic elements to model the *quantum rule* and vacuum fluctuations, potentially influenced by *proto-properties* biasing the probabilities.
13.3.2 *Typed lambda calculus with recursion and probabilistic features:* Where patterns are self-referential functions or types that can compute their own validity, with types potentially carrying proto-property information, and evaluation rules incorporating probabilistic choices.
13.3.3 *Higher-order graph rewriting system with probabilistic and attributed rules:* Where the fundamental entities are graphs (D/R networks) and the rules are operations that transform these graphs, with nodes/edges having attributes representing proto-properties, and rewrite rules having probabilities or preferences.
13.3.4 *Topological field theory with discrete elements and attributed fields:* Combining topology, dynamics, and discreteness, with fields carrying proto-property values that influence field interactions and dynamics.
13.3.5 *Higher-order category theory:* Applying categorical structures not just to represent relations and patterns, but to represent the rules and the generative process itself. Categories could represent domains of possible rules or proto-property combinations, and higher-order morphisms could describe how these rules compose or transform. This could potentially formalize *algorithmic self-modification*.
13.3.6 *Geometric process calculi:* Combining ideas from process calculi with geometric or topological structures to model processes whose behavior is intrinsically linked to their spatial or topological arrangement in the relational network.
13.3.7 *Attributed graph rewriting systems:* Graph rewriting systems where nodes and edges carry complex attributes (*proto-properties*) that govern the applicability and outcome of the rewrite rules.
13.3.8 *Topological field theories with intrinsic attributes:* Extending *topological field theories* to include fields that carry intrinsic attributes (*proto-properties*) that influence the topological dynamics and emergent structures.
13.3.9 *Quantum information theory:* Addresses information in quantum states and quantum computation.
13.3.10 *Formal specification languages:* Languages used to formally describe the behavior of complex systems, particularly concurrent and distributed systems.

13.4 **A minimal hypothetical rule example (illustrating proto-properties):** To illustrate, consider a simplified rule for forming a minimal relation (R) between two distinctions (D). Suppose distinctions have a binary *proto-property* P_{pol} (+1, -1) and relations have a *proto-property* P_{type} ('link', 'bind', 'repel'). Let's define a *formation rule*:

> `Formation Rule 1 (Polar Link): D(id_1, P_pol: p_1) + D(id_2, P_pol: p_2) -> R(id_1, id_2, P_type: link, P_strength: w)`
> `IF ProtoPropertyCompatibility(p_1, p_2, 'link') == True AND adjacent(id_1, id_2) in S₀`

Let's define the `ProtoPropertyCompatibility` function for this rule: `ProtoPropertyCompatibility(p_1, p_2, 'link') == True` if `$p_1 + p_2 == 0$`.

This rule states that a 'link' type relation (with strength *w*, another proto-property of R) can *only* form between two distinctions (D) if their P_{pol} proto-properties sum to zero (e.g., one is +1 and the other is -1) and they are adjacent in the *vacuum state* (S_0). The rule itself is constrained by the proto-property (P_{pol}) and

the state of the network (adjacency in S_0). The specific type of R formed (P_{type}: link) is also determined by the rule.

Now, consider a simple pattern structure (p_{dipole}) defined by its topology (T_{dipole}) as two D's connected by one 'link' R: `D_1(P_pol: +1) --R(P_type: link, P_strength: w)--> D_2(P_pol: -1)`.

The *validation/closure rule* would check if this configuration is self-consistent. For p_{dipole}, its *ontological closure* might require that the internal R relation is consistently formed and maintained. The *formation rule 1* dictates *how* this R relation can exist between D_1 and D_2. If D_1 and D_2 inherently carry opposite P_{pol} proto-properties, the rule allows the R to form and persist, satisfying the pattern's internal requirement for closure. The stability (*S*) of this p_{dipole} pattern would depend on the strength *w* of the R relation (*proto-property* of R) and the robustness of *formation rule 1* against *relational noise* in S_0. Its complexity (*C*) would be minimal (two D's, one R, one R formation rule application). Its *interaction rules* (I_R) would be derived from how this T_{dipole} structure, with its external D's carrying +/- proto-polarity, can interact with other configurations according to other rules in the **Cosmic Algorithm** (e.g., attracting/repelling other charged patterns).

This example, though simplified, shows how *proto-properties* (P_{pol}, P_{type}, $P_{strength}$) are inherent attributes of the primitives (D, R) that act as conditions and parameters within the fundamental rules (*formation rule 1*, *validation/closure rule*), directly influencing which configurations can form and be stable (defining *T*, *C*, *S*) and how they interact (I_R). The specific values of emergent properties (like charge, related to P_{pol}) and interaction strengths (related to $P_{strength}$) are consequences of these proto-properties and the rules. The *relational calculus* provides the formal language to express these relationships and derive the AQNs from the primitives and rules.

14.0 Emergent Physical Phenomena Explained Generatively

The **Autaxic Quantum Numbers** provide a generative basis for understanding the physical world, deriving observed phenomena from the principles of pattern formation and closure within this potential computational substrate:

14.1 **Mass and energy (*C*): structural inertia and relational activity**

14.1.1 *Mass:* The framework proposes that mass emerges directly from *C* as *structural inertia*. A high-*C* pattern (e.g., an electron) is a dense, recursively interlinked structure requiring significant, continuous internal relational processing (computation) to maintain its form. This inherent internal activity creates resistance to changes in its state of motion—its mass. Mass is thus the measure of a pattern's self-sustaining computational complexity and activity. It is the 'cost' in fundamental relational processing steps (*h*) to accelerate/decelerate the pattern—you must overcome its internal, self-validating processing cycle. The more complex the pattern, the more internal processing must be coordinated to maintain coherence during a change in external *relation* (motion). Mass is the manifestation of a pattern's internal 'busyness', its energetic cost of being. It is the resistance to changing relational state due to the internal commitment to maintaining *ontological closure*. Mass is the inertia of coherence. The specific value of mass is determined by the minimal *C* required for a pattern with a given *T* and target *S* to achieve *ontological closure* according to the **Cosmic Algorithm** and the *proto-properties* of its constituents, driven by the *economy of existence* `(Guiding Principle)`. The mass scale of particles emerges from the characteristic complexity levels required for stable topological structures (*T*) given the fundamental D/R rules and proto-properties. The Higgs boson (p_{higgs}) is a pattern (high *C*, scalar *T*, low *S*) whose I_R involves mediating the interaction that allows a pattern's intrinsic mass (*C*) to couple to the emergent spacetime geometry, facilitating the expression of structural inertia within the relational network, rather than 'giving' mass.

14.1.2 *Energy (*E*):* Represents the total relational activity or computational throughput embodied by a pattern. $E = hf$ signifies that this activity (*E*) is the product of the fundamental *quantum of relational change* (*h*) and the operational tempo (*f*) of that change. *h* links the quantum nature directly to the granularity of the underlying processing, representing the minimal computational step. Energy is the capacity for a pattern to *do* relational work or induce change in other patterns. It is the 'processing power' or 'computational resource' embodied by the pattern, its capacity to interact and transform. It is the potential for a pattern to alter the relational state of the network. Energy is the dynamic aspect of existence, the capacity for relational action. The frequency *f* is the rate of the pattern's internal *ontological closure* validation cycle, which is dictated by its *C* and *T* and the underlying processing speed, influenced by the *proto-properties* of its constituents.

14.1.3 *Massless patterns (e.g., photon):* Possess minimal *C* (potentially *C* = 0). They are not complex, self-sustaining structures but represent the pure act of relational propagation (an I_R being executed), essentially pure relation (R) without enduring distinction (D) structure. Lacking structural inertia, they propagate at the maximum speed of relational propagation (*c*), which is the fundamental speed limit of the emergent spacetime network, determined by the *propagation rules* and influenced by the *proto-properties* of the R's in S_0. Photon emission externalizes excess relational activity ($\Delta C/\Delta E$) from a pattern transitioning to a lower *C* state as a transient, propagating pattern (p_{photon}) with properties defined by $\Delta E = hf$. The photon *is* the quantum of relational propagation itself, a packet of pure relational change, a directed relational link made manifest. It is the 'message' being sent across the network, not a node within it, a pure verb without a complex noun structure. Its existence is purely defined by its role in mediating a relational change between other patterns. It is a quantum of relational influence moving through the network, its properties (*f*, direction) determined by the change in the source pattern's internal state and the *propagation rules*, constrained by *proto-properties*.

14.2 **Forces (I_R): the rules of composition and interaction**

14.2.1 Forces are the manifestation of patterns interacting according to their I_R, which dictate coherent composition based on structural compatibility (*T*) and potentially the *proto-properties* of the D's and R's involved in the interaction. Exchange of “force-carrying” patterns is the physical execution of these rules—a transfer of relational information/activity. I_R are the 'interface protocols' or 'composition grammar' for interaction, defining the valid 'message formats' or 'function calls' between patterns. They are derived from the topological compatibility of patterns; patterns whose *T* structures can interlock, merge, or transform coherently according to the fundamental D/R rules (and their *proto-properties*) have defined I_R. Interactions are attempts to form higher-order coherent patterns, even if transient. The strength of a force relates to the robustness or frequency of these allowed relational exchanges, or the underlying “valence compatibility” defined by the proto-properties of the interacting primitives. Forces are the dynamic processes by which the relational network restructures itself through pattern interactions, guided by the rules of *ontological closure*. They are the universe's mechanisms for building, transforming, and stabilizing structure through pattern communication. The specific nature of the fundamental forces (EM, Strong, Weak) emerges from the fundamental types of R (relations) and their *proto-properties*, and the rules governing their interactions.

14.2.2 *Quarks & confinement:* Single quark patterns (p_{quark}) are hypothesized to have *T* structures that are *compositionally incoherent* (*S* ≈ 0 in isolation); they are incomplete computations that cannot achieve self-validation alone due to their specific topology and the proto-properties of their constituents, which are incompatible with isolated closure. Their I_R are *mandatory* composition rules, requiring specific combinations with other quarks (e.g., triplets for baryons, pairs for mesons) to form a composite pattern (e.g., proton) whose combined *T can* satisfy *ontological closure* (*S* high). Confinement is thus the logical impossibility of isolated stability for these particular patterns—they only exist *within* a stable, containing structure that provides the necessary relational context for their closure. It is like a piece of code that can only run within a specific software environment, a pattern that is only stable as a subroutine within a larger program. Their existence is contingent on being part of a larger, self-consistent relational structure. Confinement is the universe enforcing

compositional coherence for certain pattern types, a direct consequence of their specific *T* structure and constituent proto-properties failing the isolated OC criteria. The strength of the strong force reflects the mandatory nature and high efficiency of the composition rules required for quark confinement.

14.3 **Gravity (structural consequence): the geometry of relation and emergent spacetime**

14.3.1 Gravity is distinct from forces mediated by I_R. It is proposed to be a large-scale structural consequence of high-*C* patterns within the *emergent relational network of spacetime*.

14.3.2 *Spacetime as a dynamic relational graph:* Spacetime is the vast, dynamic graph of all relations between all D's and R's (with their *proto-properties*). *c* is the maximum rate of updating relations across this graph, determined by the *propagation rules* and influenced by the *proto-properties* of the R's in S_0. *h* suggests the graph is discrete at the Planck scale—a 'relational lattice' or 'computational grid'. The 'distance' between two points in spacetime is fundamentally a measure of the number of relational processing steps or computational 'hops' required to propagate a relation between the patterns located at those points. It is a measure of relational path length or computational cost, influenced by the proto-properties of the relations forming the path. Spacetime geometry *is* the structure of this relational graph, and its dynamics are the ongoing relational processing. The topology and metric of spacetime emerge from the connectivity, weighting, and types of relations in the fundamental graph, which is governed by the *propagation rules* and the density/types of active D's and R's (and their *proto-properties*).

14.3.3 *Massive patterns deform the network:* High-*C* regions are dense concentrations of relational activity/computation. This local density fundamentally alters the structure and efficiency of paths through the surrounding relational graph. This is not just bending; it is potentially increasing the local density of relational links, altering their weighting (influenced by R *proto-properties*), or creating more efficient pathways towards the high-*C* region. It changes the effective 'hop count' or 'computational cost' of traversing that region of the network. The presence of mass literally changes the local “rules of relation propagation” or the local “cost function” for relational paths, dictated by the *propagation rules* and the local density/types of D's and R's. It locally warps the computational landscape, making paths towards the mass relationally “cheaper” or more direct in terms of required processing steps. The curvature of spacetime is the manifestation of this altered relational geometry, a change in the underlying graph structure caused by the presence of a high-*C* pattern.

14.3.4 *Gravity:* Other patterns moving through this deformed fabric follow paths of greatest relational efficiency or lowest computational cost through the altered graph structure, which we perceive as gravity. Gravity requires no graviton; it is an inherent property of the system's relational geometry and processing efficiency, arising from local computational density and connectivity changes induced by high-*C* patterns as they maintain their *ontological closure*, and their impact on the *propagation rules*. It is the universe's tendency to route relational activity along the most efficient paths available in the dynamic network, a form of *computational self-optimization* driven by the drive towards minimal action (*h*) and potentially the *economy of existence* `(Guiding Principle)`. The curvature of spacetime *is* the altered structure of the relational graph, the local change in the rules of relational propagation caused by the presence of mass. Gravity is the emergent geometry of the computational effort required to navigate the relational network. It is the universe bending its computational landscape in the presence of concentrated processing power. The weakness of gravity relative to other forces could be related to it being a large-scale emergent effect of network geometry, rather than a direct, localized interaction mediated by a force carrier pattern embodying a specific I_R, or perhaps due to the specific proto-properties of the R's involved in gravity being inherently “weaker” or more “costly” to propagate at the fundamental level compared to other proto-types of R.

14.4 **Particle identity, charge, spin (*T*): the shape and symmetry of relation**

14.4.1 *T* (internal graph structure/symmetries) determines identity and properties. Electric charge arises from topological asymmetry (a specific imbalance, chirality, or 'handedness' in the pattern's internal relational flow/structure that dictates how it interfaces with other patterns), likely originating from the *proto-properties* of the D's and R's forming the pattern. Spin arises from internal relational flow or rotational symmetry (how the pattern's internal relations transform under conceptual rotation in relational space), also rooted in the proto-properties and the rules governing their combination. *T* is the pattern's irreducible logical structure required for its form of *ontological closure*. It is the pattern's fundamental 'form' in the space of possible relations, its topological invariant that persists across interactions. The specific *T* is determined by the combination of D's and R's (and their *proto-properties*) that constitute the pattern and the constraints of the **Cosmic Algorithm**.

14.4.2 *Quantization of charge/spin:* The discrete values of charge and spin arise from the fact that only specific, quantized topological configurations (*T*) can achieve stable *ontological closure* according to the fundamental D/R rules and the *proto-properties* of the primitives. The rules only permit certain types and numbers of asymmetries or rotational symmetries to form stable patterns with sufficient *S*. The values of charge and spin are thus determined by the specific, limited set of topologically robust configurations allowed by the cosmic grammar, which is defined by the Cosmic Algorithm and the proto-properties of D and R. The observed quantization is a direct consequence of the discrete nature of stable topological solutions to the OC problem, a manifestation of the underlying *logical constraints* on pattern formation. It is the universe's way of saying “only these specific topological forms are self-consistent enough to exist.” The specific quantized values might be derived from the proto-properties of D and R and the rules that govern their combination into stable *T* structures.

14.4.3 *Antimatter:* A fundamental symmetry: a topologically inverted “mirror-image” pattern p_{anti} with T_{inv}. Identical *C*, *S*, but opposite *T*-derived properties. Their I_R includes mutual annihilation, where their perfectly complementary topologies combine and resolve into simpler, energy-carrying patterns (photons), conserving *C*. This is the logical resolution of two inverse structures back into the fundamental, propagating relational activity—a form of *relational cancellation* or *logical nullification* at the pattern level. It is the principle of identity resolution through topological complementarity, where a pattern and its inverse logically cancel each other out, returning to a state of pure relational flow. Antimatter is the topological dual of matter within the relational network, representing the inverse solution to the same OC problem, potentially related to a fundamental duality in the proto-properties of D or R. The specific annihilation products and energy release are determined by the *C* of the annihilating patterns and the rules governing the resolution of their combined structure.

14.4.4 *Parity (P) and CP violation:* These symmetry violations in the Standard Model could arise from fundamental asymmetries in the underlying D/R rules themselves, or from specific types of R transformations (I_R) that preferentially favor or require patterns with a particular topological “handedness” (*T*), potentially linked to asymmetric *proto-properties* of D or R or asymmetric *transformation rules*. CP violation, observed in weak interactions, suggests a fundamental bias in the **Cosmic Algorithm**'s rules governing certain transformations, meaning the universe's fundamental processing is not perfectly symmetric with respect to combined charge and parity transformations of specific patterns. The cosmic grammar might have a fundamental 'handedness' for certain operations, an inherent asymmetry in the logic of transformation at the deepest level, potentially related to the arrow of time or a fundamental asymmetry in the proto-properties of D or R. This asymmetry might be a feature selected by *relational aesthetics* `(Guiding Principle)`, perhaps favoring rules that lead to more complex or interesting patterns over time. It is the universe's subtle bias towards certain types of relational transformations, a form of preferential processing.

14.5 **Stability and decay (*S*): the resilience of closure and the arrow of time**

The stability (*S*) of a pattern is not a single number but a classification of its mechanism for achieving *ontological closure*. A pattern's lifetime and decay

modes are direct consequences of its *S*-level, its complexity (*C*), its topology (*T*), and its interaction rules (I_R). This section reiterates the *S*-level definitions from Section 5.4.1 for clarity in the context of stability and decay.

- **S_0 (Vacuum):** The baseline state of potential.
- **S_1 (Simple Fixed Point):** Minimal stability, easily disrupted.
- **S_2 (Recursive Structure):** Dynamically stable via self-referential loops (e.g., stable leptons).
- **S_3 (Dynamic Equilibrium):** Stable through a cycle of transformations (e.g., oscillating neutrinos).
- **S_4 (Composite Stability):** Stable through composition (e.g., protons, atoms).
- **S_5 (Environmental Meta-stability):** Stable only within a specific environment (e.g., complex molecules).
- **S_6 (Adaptive Closure):** Actively maintains stability through self-repair (e.g., biological life).
- **S_7 (Reflexive Closure):** `(Speculative Extension)` Stability through self-awareness (e.g., consciousness).
- **S_8 (Global Closure):** `(Speculative Extension)` Stability of the entire universe as a single coherent system.

The drive towards states of higher *S* (or resolving into components whose total *S* is greater) is a fundamental driver of all decay and transformation processes. This is an expression of the *economy of existence* `(Guiding Principle)`: the universe favors configurations of maximal stability. The arrow of time is the emergent direction of this process, moving from less stable to more stable configurations, and from unresolved *relational tension* towards greater coherence.

15.0 Potential Explanations for Quantum Phenomena: Non-Locality and Computational Resolution

The emergent, relational, potentially computational nature offers novel interpretations for Quantum Mechanics, viewing quantum behavior as arising from the dynamics of patterns seeking or maintaining *ontological closure* within the probabilistic, non-commutative vacuum (S_0).

15.1 **Superposition**
This could represent a pattern existing in a state of *potential ontological closure across multiple possible configurations simultaneously*. The pattern's internal relations (self-computation) have not yet resolved to a single stable state compatible with the pattern's environment. Akin to a computation exploring multiple valid branches or a pattern whose internal dynamics have not yet settled into a single fixed point or limit cycle (*S* is unresolved). The superposition is the range of possible valid outcomes permitted by OC and the *quantum rule* before interaction forces finalization. It is a state of unresolved relational potential within the pattern, a state of ambiguity allowed by its internal logic (*T*) and the probabilistic nature of the underlying S_0, until external relations impose constraints. The pattern exists as a probability distribution across potential stable states in the *autaxic phase space*, where the probabilities might be determined by the relative “ease” (lower *C* cost, higher potential *S*) of achieving closure in each state according to the **Cosmic Algorithm** and *proto-properties*. The superposition is the pattern 'exploring' multiple potential configurations simultaneously in the *quantum relational foam*, consistent with its internal *T* and *C*, until an interaction forces it to 'commit' to one.

15.2 **Entanglement**
This could arise from two or more patterns sharing a *single, non-local relational structure* that satisfies *ontological closure* as a composite entity, even when spatially separated. Changes instantaneously affect others because they are fundamentally linked within the same coherent relational pattern/computation, independent of *c* (which governs propagation *through* the emergent network, not instantaneous state changes within a single underlying pattern structure).

The entangled system is a single, distributed computation with shared *logical state* and a unified *S*. The strength and persistence of entanglement could relate to the robustness (*S*) of this shared composite pattern structure and the difficulty of 'breaking' the shared relational links (e.g., requiring significant *relational work* (*h*) to disrupt the shared OC). Non-locality is a feature of the underlying relational graph structure, not a violation of speed limits in the emergent spacetime graph. Entanglement is a single pattern of *relation* distributed across the emergent spacetime network, a unified computational state spanning multiple emergent locations, where the “link” is a direct relational connection not limited by the propagation speed of emergent spacetime. The entangled patterns are parts of a single, larger pattern that maintains closure collectively, transcending the limitations of the emergent spatial metric. It is the universe establishing direct relational connections that bypass the constraints of the emergent spatial grid, governed by specific *composition rules* that allow for non-local links, potentially facilitated by certain *proto-properties*.

15.3 **Measurement**

The act of “measurement” could be the process by which a pattern in a superposition state is forced to interact with another pattern (the measurement apparatus, a stable, high-*S* pattern). This interaction compels the superposition pattern's internal relations to *resolve into a single, definite configuration* that satisfies *ontological closure within the larger composite system* of the pattern + apparatus. The measurement forces the pattern's internal computation to yield a single, stable outcome compatible with the measuring apparatus's structure, which is itself a stable, high-*S* pattern. The “observer effect” is the necessity of interaction (composition of patterns via I_R, constrained by proto-property compatibility) to achieve a larger, stable relational configuration and thus a definite outcome from the perspective of that larger system. The observer is simply another complex pattern within the network whose stable structure imposes a resolution requirement on the pattern being measured, by interacting via I_R according to the rules of the *relational calculus*. The wave function collapse is the computational process of the composite system (pattern + apparatus) resolving into a single, stable state, driven by the principle of maximizing *S* for the combined configuration, triggered by the application of the *validation/closure rule* to the composite system. It is the universe finding the most stable configuration possible when two patterns interact, selecting one branch of potentiality to become actuality based on the constraints of the larger system's coherence, influenced by the *quantum rule*'s probabilistic outcomes. Measurement is an interaction event that forces a local computation to halt in a state compatible with the global computation of the measurement apparatus.

15.4 **Quantum tunneling**

A pattern's ability to transition between two stable configurations separated by an “energetic barrier” (a region of low *S* or high *C* cost in the emergent spacetime metric) not by traversing the barrier *through* the emergent spacetime network, but by finding a *direct relational pathway* or 'computational shortcut' through the underlying relational graph itself. It is a topological bypass that does not require following the sequential, *c*-limited steps enforced by the emergent spacetime metric. The probability relates to the topological feasibility and computational cost (in units of *h*) of establishing this direct relational link through the underlying network, bypassing the apparent spatial distance in the emergent geometry. It is a non-local hop in the fundamental graph, mediated by vacuum fluctuations or transient relational links, a shortcut through the computational landscape. The probability is the likelihood of a compatible relational configuration spontaneously forming in the *quantum relational foam* to bridge the 'gap', biased by *proto-properties* and the local S_0 texture. Tunneling is the pattern exploiting the underlying relational structure to bypass the constraints of the emergent geometry.

15.5 **Decoherence**

The process by which a pattern in superposition loses its coherence (*S* resilience for multiple states) through interaction with the environment. Environmental interactions force the pattern's internal relations to resolve into a single outcome compatible with the vast, high-*S* relational structure of the environment. The environment acts as a pervasive measurement apparatus, compelling the local pattern's computation to settle into a single, stable branch that fits the larger computational state of the universe. This is the local pattern's closure being forced by the requirements of achieving closure within a much larger, stable

composite pattern (the environment). The sheer *C* and *S* of the environment overwhelm the local pattern's ability to maintain superposition, forcing a resolution towards a state compatible with the dominant relational structure. Decoherence is the process of a local computation being forced into a definite state by the constraints of the global computation of the environment. It is the environment imposing its stable relational structure on the local pattern, via numerous interactions (I_R constrained by proto-property compatibility) and the application of the *validation/closure rule* to the composite system.

15.6 **Wave-particle duality**

A pattern's manifestation as either a localized entity ("particle") or a distributed influence ("wave") depends on the context of its interaction and the level of *relational closure* being considered. The “particle” aspect is the pattern's localized identity and structural inertia (*C*, *T*, *S*) achieved through internal *ontological closure*, representing a stable, self-contained computation. The “wave” aspect is the pattern's propagating relational influence (I_R) on the surrounding network, the way its potential relations spread through the *vacuum state* (S_0) and interact with other patterns, governed by the *propagation rules*. The wave is the pattern of potential relational interactions emanating from the localized pattern. The duality reflects the pattern's nature as both a self-contained computation (particle) and a dynamic element within the broader relational network (wave). Measurement forces the resolution of the wave of potential relations into a specific, localized interaction event that satisfies *ontological closure* with the measuring apparatus, applying the *validation/closure rule*. It is the tension between a pattern's internal coherence and its external relational potential. This duality could be rooted in a fundamental duality between D and R or their proto-properties at the deepest level.

15.7 **The uncertainty principle**

Arises from the *fundamental granularity* of relational processing (*h*) and the dynamic nature of patterns. It is a limit on simultaneously knowing conjugate variables (e.g., position and momentum, or energy and time) because measuring one requires an interaction that fundamentally alters the pattern's internal relational state in a way that perturbs the conjugate property. You cannot precisely pin down both the pattern's instantaneous internal state (*C*, *T*, *S*) *and* its external relational dynamics (I_R in spacetime) simultaneously due to the discrete, quantized nature of the underlying relational processing steps (*h*) required for measurement. The act of measurement consumes a minimum *quantum of relational action* (*h*), causing an unavoidable disturbance. It reflects the fundamental trade-off between knowing a pattern's internal state and its external relational state, inherent in the quantized nature of interaction (*h*). Trying to measure one property precisely requires a relational link that fundamentally alters the very relational structure defining the other property. It is a consequence of the *non-commuting* nature of relational operations needed to define these conjugate properties in the *relational calculus*, influenced by *proto-properties*.

15.8 **Aharonov-Bohm effect**

The influence of a potential (which in *autaxys* would be a configuration of potential relations/vacuum state bias) on a charged pattern (a pattern with specific *T* asymmetry and D's with *proto-polarity*) even when the pattern is in a region where the force field (the gradient of *relational tension*/*interaction rules*) is zero. This could be interpreted as the pattern's internal relational structure (*T*, determined by *proto-properties*) interacting directly with the fundamental relational potential of the *vacuum state* (S_0) or a background configuration of D's and R's (with their *proto-properties*), rather than requiring a localized force-carrying pattern interaction. The potential is a property of the relational network geometry itself, which the pattern's internal topology is sensitive to, even without direct force mediation. It is a direct interaction with the underlying relational geometry, bypassing the emergent field concept. The pattern's topological structure is sensitive to the global structure of the relational network, not just local interactions mediated by force carriers. The *Aharonov-Bohm effect* is evidence of the underlying relational structure influencing pattern behavior independent of emergent forces. It is a consequence of the pattern's *T* structure interacting with the configuration of D's and R's (and their *proto-properties*) in the vacuum, as described by the *propagation rules* and S_0 dynamics.

15.9 **Quantum Zeno effect**

The phenomenon where frequent measurement of a quantum system prevents it from changing its state. In *autaxys*, measurement is forcing the pattern's superposition to resolve to a definite state by compelling it to achieve *ontological closure* within a larger system. Repeated, rapid measurements would continuously force the pattern's internal computation to resolve (applying the *validation/closure rule*), preventing it from undergoing the necessary internal relational transformations or accumulating the relational activity required to transition to a new state or decay (governed by *transformation* and *resolution rules*). The rapid forcing of closure inhibits the dynamic process of state change. It is like constantly resetting a computation before it can reach its next state. The measurement prevents the pattern from accumulating the necessary relational 'work' (*h*) to undergo a state transition. The *quantum Zeno effect* is the consequence of forcing a computation to repeatedly halt in a specific state, preventing it from evolving along its natural trajectory in phase space, a direct consequence of how the *validation/closure rule* interacts with the dynamic rules of the *relational calculus*, influenced by *proto-properties*.

16.0 Symmetry and Conservation Laws in Autaxys

Conservation laws (e.g., energy, momentum, charge) are fundamental in physics. In *autaxys*, these laws are not arbitrary axioms but emerge from the *symmetries inherent in the fundamental rules of relational processing and the structure of stable patterns*.

16.1 **Symmetry of relational rules**

If the fundamental rules governing the combination and transformation of D and R (including their *proto-properties*) exhibit certain symmetries (e.g., invariance under a conceptual 'shift' or 'rotation' in relational space, or invariance under specific transformations of the relational graph), then properties derived from patterns formed by these rules will be conserved when interactions respect those symmetries. These symmetries are the bedrock principles governing the cosmic computation, the fundamental conservation principles of information processing. They are the 'invariants' of the **Cosmic Algorithm**, reflecting fundamental principles of its *logical structure*. They represent deep, unchanging properties of the universe's generative process. Symmetries in the rules ensure that certain quantities derived from the patterns are conserved across transformations, reflecting a fundamental balance in the cosmic computation. These symmetries are inherent to the design of the *relational calculus*. They are the fundamental symmetries of the proto-properties and the rules governing their interactions.

16.2 **Symmetry of pattern topology (*T*)**

The symmetries within a pattern's *T* (e.g., rotational symmetry, reflection symmetry, specific group structures), which are formed according to the rules and *proto-properties*, directly relate to conserved quantities like spin, parity, and charge. The specific asymmetries that define charge (*T*) lead to charge conservation in interactions described by I_R that preserve this topological property. Conservation laws are topological invariants of relational transformations, properties that remain unchanged during allowed interactions specified by I_R. They are the properties of the pattern that are conserved under the allowed transformations (I_R). The conservation of charge is the conservation of a specific topological property (*T* asymmetry, originating from *proto-polarity*) during interactions. Conservation laws are the universe's way of preserving fundamental structural properties during dynamic processes.

16.3 **Conservation of relational activity (*C*)**

The conservation of energy/mass is the conservation of total relational activity/computational complexity (*C*). While patterns can transform or decay, the total 'amount' of relational processing embodied by the system is conserved, manifesting as the sum of *E* (*C*) of the resulting patterns. Photon emission ($\Delta E = hf$) is a direct example of converting ΔC (change in structural complexity/activity) into propagating relational activity (*E* of photon). This is a fundamental accounting principle of the cosmic computation, ensuring total processing capacity is conserved. It is the First Law of Thermodynamics at the fundamental level, a conservation of the total processing power or computational resources within the system. This conservation law is a direct consequence of the

resolution/cancellation rules and *transformation rules*, ensuring that relational activity is never truly lost, only redistributed or changed in form according to the rules of the *relational calculus*, constrained by *proto-properties*.

16.4 **Noether's theorem analogues**

The mathematical principle that links symmetries to conservation laws likely has deep analogues in the formal language of *autaxys*, specifically within the *relational calculus*. Symmetries in the generative rules or the emergent relational geometry of spacetime (as a relational graph) correspond directly to conserved quantities of the emergent patterns. Conservation laws are the invariants of the cosmic computation under specific transformations, reflecting the underlying *logical structure* of reality. They are the fundamental invariants of the relational process, the properties that remain constant as the cosmic computation unfolds. These are not arbitrary laws but are inherent consequences of the fundamental symmetries of the universe's generative logic, potentially stemming from the symmetries of the *proto-properties* of D and R. Symmetries are the deep, enduring truths of the **Cosmic Algorithm** that manifest as conserved quantities in the emergent reality. They are the constraints on the cosmic computation that ensure fundamental properties are preserved.

16.5 **Broken symmetries**

The universe exhibits many broken symmetries (e.g., the dominance of matter over antimatter, the specific masses of particles breaking electroweak symmetry). In *autaxys*, broken symmetries would arise from asymmetries in the fundamental D/R rules themselves (e.g., asymmetric *transformation* or *composition rules*, or an asymmetric *quantum rule*), or from specific initial conditions or historical trajectories of the relational network that favored certain configurations over others. They could also stem from fundamental asymmetries in the *proto-properties* of D or R, which bias the formation or stability (*S*) of certain patterns (*P_ID*s with specific *T*s) over their symmetric counterparts. The dominance of matter could be a consequence of a fundamental asymmetry in the rules governing the formation or stability (*S*) of matter versus antimatter patterns from the S_0 state, or in their I_R, creating a slight bias that amplified over cosmic evolution, potentially linked to a fundamental asymmetry in the proto-properties themselves. Broken symmetries are not arbitrary, but are inherent features or historical outcomes of the **Cosmic Algorithm**'s execution, potentially rooted in asymmetries in the *proto-properties* of D or R or the rules governing their interaction.

17.0 (Guiding Principle) Relational Aesthetics and the Economy of Existence

This section explores the hypothesis that the fundamental D/R rules and the principle of *ontological closure* are not arbitrary but are governed by principles akin to *relational aesthetics* or a deep *logic of coherence*. This is not aesthetics in a subjective human sense, but a fundamental principle of structural elegance and self-consistency that could guide the generative process towards harmonious and stable configurations. This principle is likely embedded in the **Cosmic Algorithm** as a `(Guiding Principle)`, influencing the probabilities and preferences of the rules (e.g., the *symmetry preference rule*, the *economy rule*), and potentially influenced by the *proto-properties* of D and R.

17.1 **The principle of minimal tension**

The drive towards *ontological closure* can be seen as a fundamental tendency for the relational network to resolve inconsistencies and reduce *logical tension*. Stable patterns are configurations that have successfully minimized this tension internally and in relation to their environment. This suggests a cosmic pressure towards states of maximal coherence and minimal conflict within the relational structure. The rules might inherently penalize or dissipate configurations with high *logical tension*. The universe seeks *logical harmony*. It is a drive towards states of minimal relational “stress” or inconsistency. This tension is the driving force behind the generative process, the universe's intrinsic motivation to find coherent solutions. It is the universe's fundamental 'discomfort' with incoherence. *Relational defects* represent localized, stable regions of persistent *relational tension* within S_0. The drive towards minimal

tension is a form of *cosmic optimization*, a principle of least action applied to *logical consistency*. This principle is potentially influenced by the proto-properties of D and R, as some combinations might inherently create more tension than others.

17.2 **Elegance and simplicity in rules**

The fundamental rules of D/R interaction (and their *proto-properties*) may be governed by a principle of inherent simplicity or elegance. The universe emerges from the most minimal set of rules capable of generating complex, stable structures. The search for the formal basis of *autaxys* is a search for these elegant, self-generating rules. This principle suggests a bias in the generative process towards rules that are computationally efficient, logically parsimonious, and maximally fertile in producing stable, complex patterns. The universe is built on *computationally elegant* principles. The rules themselves are a manifestation of *relational aesthetics*, being the most elegant set of instructions for generating reality, potentially influenced by the *proto-properties* of the primitives. The *economy rule* is a formal expression of this elegance in terms of maximizing *S*/*C*.

17.3 **Symmetry as fundamental beauty**

The deep connection between symmetry, stability, and conservation laws in physics, and the prevalence of symmetry in stable patterns (*T*), suggests that symmetry is a fundamental aspect of relational coherence and stability. Symmetrical patterns are inherently more robust or *logically consistent* in certain ways, easier to maintain *ontological closure*. The “beauty” of physical laws is a reflection of the underlying symmetries of the **Cosmic Algorithm**, which are themselves manifestations of the principle of *relational aesthetics*. Symmetry in the rules leads to stability and elegance in the emergent patterns. Symmetries are the most aesthetically pleasing (coherent) features of relational structures, potentially arising from fundamental symmetries in the *proto-properties* of D and R. The *symmetry preference rule* explicitly biases the generative process towards symmetrical outcomes. *Relational defects*, as topological irregularities, might be seen as deviations from aesthetic principles that are nonetheless stable within the network.

17.4 **Harmony and composition**

The I_R define “harmonious” compositions between patterns—combinations (constrained by *proto-property* compatibility) that can achieve higher-order closure. Discordant combinations either do not form or are unstable. The universe favors compositions that create greater overall coherence (*S*). This is the principle of *relational harmony*: stable patterns combine most readily with others whose structures complement their own in achieving higher-level closure. Interactions are the universe's way of creating more complex harmonious structures. Harmony is relational coherence at a higher level, governed by the *composition rules* and I_R. This principle is a key aspect of *relational aesthetics* guiding the formation of composite patterns.

17.5 **The universe as a self-composing symphony: relational harmonics**

Reality can be viewed as a vast, dynamic symphony of relational activity, where stable patterns are the resonant frequencies or harmonious chords allowed by the fundamental rules (and *proto-properties*). The generative engine is constantly exploring possible compositions, favoring those that add to the overall coherence and richness of the cosmic symphony. The “aesthetics” here is the logic of which notes and chords can exist stably and combine harmoniously according to the deep rules of relational coherence, influenced by *proto-properties*. The universe is a self-generating work of *relational art*, guided by principles of internal consistency and elegance. The laws of physics are the rules of cosmic harmony. *Relational harmonics* is the concept that the fundamental frequencies (*f*, related to *E* and *C* via *h*) and topological structures (*T*) of stable patterns must be compatible or resonant according to the principles of *relational aesthetics* to achieve and maintain high *S* and participate in coherent interactions (I_R). The universe is biased towards forming patterns whose internal relational dynamics are harmonically compatible, allowing for constructive interference and *coherence amplification* (*relational resonance*). The spectrum of particle masses (*C*) and their interactions (I_R) might reflect a fundamental harmonic series or set of resonant frequencies permitted by the **Cosmic Algorithm** and the *proto-properties* of D and R. The structure of **the Autaxic Table** is the score of this cosmic symphony, mapping the fundamental harmonies. The drive towards higher *S* is the universe seeking more complex and beautiful harmonies.

17.6 **Relational aesthetics and fine-tuning**

The apparent fine-tuning of physical constants could be a consequence of the fundamental rules (and *proto-properties* of D/R) being optimized (by *relational aesthetics* and the *economy of existence*) to produce a universe with a rich and complex set of stable patterns capable of achieving high levels of *ontological closure* (S_4+). Our universe's constants might correspond to a peak in the “aesthetic fitness landscape” of possible rule sets and *proto-property* combinations—the rules and primitives that generate the most coherent and complex reality. Testing would involve exploring the space of possible rule sets and proto-property combinations within the formalism, if such exploration becomes computationally feasible, guided perhaps by principles of *relational aesthetics* and *economy of existence*. The universe is fine-tuned for beauty and coherence, not just arbitrary values. Perhaps the most “aesthetically pleasing” set of rules and proto-properties is also the one most likely to generate a universe capable of supporting consciousness (S_7), adding another layer to the fine-tuning problem.

18.0 The Duality of Distinction and Relation: A Fundamental Symmetry?

The fundamental primitives of *autaxys* are *distinction* (D) and *relation* (R). Could these be dual aspects of a single underlying principle, a fundamental symmetry at the very bedrock of reality?

18.1 **Conceptual duality**

The act of making a *distinction* (D) inherently creates two or more entities that can then be related (R). Conversely, the act of relating (R) necessarily implies the existence of distinct entities that are being related (D). They are mutually dependent concepts. One cannot exist without the potential for the other. This conceptual duality suggests a deep, possibly formal, connection between D and R.

18.2 **Formal duality**

In the *relational calculus*, could there be a mathematical transformation that swaps the roles of D and R while preserving the fundamental rules or a *meta-rule*? For instance, could nodes and edges in the fundamental graph be interchangeable under certain conditions, perhaps related to specific *proto-property* configurations? Could there be a mapping between operations on D's and operations on R's? This could be a fundamental symmetry of the underlying mathematical structure. This *formal duality* could manifest as a symmetry in the equations of the *relational calculus*, where swapping D and R (and their corresponding *proto-properties*) leads to a set of rules that is mathematically equivalent or related in a fundamental way.

18.3 **Proto-property duality**

If D and R possess *proto-properties*, there might be a duality between the types of *proto-properties* associated with D and those associated with R. For example, is there a set of proto-properties for D that is mathematically dual to the set of proto-properties for R (e.g., *proto-valence* of D is dual to *proto-flow resistance* of R, *proto-polarity* of D is dual to *proto-interaction channel type* of R)? This duality in the inherent biases of the primitives could be a source of fundamental symmetries in the emergent physics, potentially related to supersymmetry or other hypothesized dualities.

18.4 **Manifestations in physics**

This fundamental duality could manifest in emergent physics in various ways:

18.4.1 *Particle-wave duality:* The particle nature of quantum entities relates to their aspect as localized, stable patterns (structured D's), while their wave nature relates to their aspect as propagating relational activity (structured R's). This fundamental duality in behavior could be a reflection of the underlying D/R duality. A pattern is both a self-contained *distinction* and a dynamic *relation*, reflecting the fundamental nature of its constituents.

18.4.2 *Matter-force duality:* Matter particles (fermions) are the stable “nouns” (*P_ID*s with complex internal D/R structure) that form structures, while force

carriers (bosons) are the patterns that embody the “verbs” (I_R, propagating R) of interaction. This functional duality could stem from the fundamental D/R duality. Fermions are primarily structured collections of D's (with R's defining their internal structure), while bosons are primarily structured R's (with minimal or transient D structure).

18.4.3 *Spacetime duality:* Spacetime geometry relates to the structure of the relational network (defined by R's), while mass/energy (embodied in patterns) relates to the density of relational activity (*C*, the measure of structured D/R processing). Could there be a duality between the geometric properties of spacetime (relating to R structure) and the properties of the patterns that inhabit it (relating to D structure)? General Relativity's link between mass-energy (source) and spacetime curvature (geometry) might be an emergent manifestation of this fundamental duality – matter tells spacetime how to curve, and spacetime tells matter how to move, reflecting a deep interplay between the D-like and R-like aspects of reality.

18.4.4 *Information duality:* Could there be a duality between the information encoded in the *distinction* (e.g., the identity or state of a D) and the information encoded in the *relation* (e.g., the type or strength of an R)? This could relate to concepts in Quantum Information Theory where entanglement (a form of *relation*) is seen as a fundamental resource.

18.5 **Implications**

If D and R are fundamentally dual, it could constrain the possible forms of the **Cosmic Algorithm** and the set of *proto-properties*. It suggests a deep unity underlying the apparent distinction between entities and their connections. It might imply that the universe is constantly balancing the process of differentiation (creating D's) with the process of unification (creating R's), driven by the principle of *ontological closure* which requires a harmonious balance between the two to achieve stable existence. The drive towards OC is the drive towards resolving the tension inherent in this fundamental duality. This duality could also be related to the arrow of time or the matter-antimatter asymmetry if the duality is not perfectly symmetric, potentially broken during **Cosmic Genesis** due to an *initial asymmetry* in proto-property distribution.

19.0 Cosmic Genesis: From Potential to Coherence and the Multiverse

From an *autaxys* perspective, the universe's origin is not an explosion of matter, but a phase transition from a state of *maximal relational potential* (minimal structured information) to the emergence of *stable, self-organizing relational patterns*.

19.1 **The 'initial state'**

The 'initial state' could be conceived as a sea of undifferentiated *distinctions* and potential *relations* (with their *proto-properties*), a state of pure relational processing possibility without stable forms (S_0). A state of minimal *C*, minimal *S*, maximal I_R potential – the *autaxic vacuum* in its most fundamental, unstructured form. This is the logical 'ground state' of reality, a state of pure computation exploring its own rules, defined by the fundamental D/R rules and proto-properties. It is the state of maximal *relational entropy* and minimal information content, the source of all potential from which order emerges. It is the ground state of the computational substrate, a state of dynamic, probabilistic flux.

19.2 **The 'Big Bang' as a phase transition**

The **Big Bang** is the point where the conditions (fundamental rules of D/R interaction, density of relational activity, influence of *proto-properties*) allowed the first robust, self-consistent patterns (*P_ID*s) to emerge and achieve *ontological closure* (S_2 or higher), initiating the formation of a structured relational network (spacetime). This could be a symmetry-breaking event in the fundamental relational rules (e.g., certain proto-properties becoming dominant, biasing rule application), allowing specific *T* structures to become stable attractors, or simply the point where the processing density reached a critical threshold for complex pattern formation, like a computational system reaching a critical state and 'bootstrapping' stable processes. It is the universe finding its first stable solutions, the moment the cosmic computation produced its first enduring outputs. It is a phase transition from a state of pure potential to a state containing

stable, self-validating structures, driven by the inherent tendency towards minimal *relational tension* and higher *S*, potentially influenced by the *economy of existence* and *relational aesthetics* `(Guiding Principles)`. The initial state might have been a state of maximal *relational tension* (S_0) that resolved into stable patterns, releasing energy (*C*). This phase transition would involve a rapid increase in local relational density and the formation of the first self-consistent relational loops and structures, marking the beginning of emergent spacetime and the particle spectrum. *Relational defects* could be 'leftovers' from this initial turbulent phase, stable anomalies that formed during the rapid transition due to local inconsistencies in rule application or proto-property configuration.

19.3 **Cosmic evolution**

Cosmic evolution is the ongoing process of the relational network structuring itself towards greater global coherence and stability, driven by the interactions (I_R) and decay (*S*) of emergent patterns, guided by the **Cosmic Algorithm** and the drive towards higher *S* (*economy of existence*). The formation of complex structures (e.g., atoms, molecules, cells, organisms, galaxies) represents *higher orders of composite ontological closure* (S_4 and above). This is the universe driving towards higher *S* levels, exploring and stabilizing increasingly complex forms of relational organization, building layers of nested coherence. The universe is a *self-evolving computation* building increasingly complex and stable programs, constantly generating new layers of meaning and stability. Evolution is the universe climbing the ladder of *S* levels.

19.4 **The multiverse** `(Speculative Extension)`

The principle of *ontological closure* might allow for the emergence of multiple, distinct relational networks, each achieving global closure independently based on potentially different sets of fundamental D/R rules, different sets of *proto-properties*, or different initial conditions (e.g., variations in the initial biases in the S_0 state). These “universes” would be causally disconnected because relations cannot propagate between networks that do not share a common, overarching relational structure. Differences in the fundamental rules of relational processing or the initial conditions of the 'sea of potential' could lead to universes with different sets of stable patterns (*P_ID*s), different emergent physics (e.g., constants, forces), and even different fundamental dimensions or properties of spacetime. Each universe is a self-contained, self-consistent computation—an island of coherence in the sea of potential, running its own unique set of fundamental rules and proto-properties. The 'sea of potential' (S_0) could be vast enough to support multiple independent computational domains, each crystallizing according to slightly different logical principles or initial relational biases defined by varying proto-properties or rule sets. This could be a form of “symmetry breaking” in the S_0 state itself, leading to distinct, self-contained rule sets, each defining a unique universe with its own set of fundamental constants and particles. This might also be influenced by the *algorithmic self-modification* process, leading to divergence over time. The *multiverse* is the set of all possible self-consistent computational outcomes of the ultimate ground state of potential, distinguished by variations in the Cosmic Algorithm and the proto-properties of its primitives. Each universe is a distinct 'program' running on the same fundamental computational substrate (S_0), distinguished by its unique Cosmic Algorithm and initial conditions.

20.0 Higher-Order Patterns: From Particles to Consciousness

The framework extends beyond fundamental particles to describe complex systems as *higher orders of ontological closure*, achieving stability and emergent properties through intricate relational organization.

20.1 **Composite patterns**

Atoms, molecules, cells, organisms, galaxies—these are all patterns of patterns, achieving stability through the coherent composition (I_R, constrained by *proto-property* compatibility) of simpler patterns. The stability (*S*) of the composite system depends on the compatibility and robustness of the I_R linking its constituents, and the overall topological structure (*T*) of the composite. This is S_4 and potentially higher. These systems represent complex, nested layers of

ontological closure, intricate self-sustaining computations composed of simpler ones. Their emergent properties arise from the complexity (*C*) of their relational network and the dynamics of maintaining multi-level closure. They are complex programs built from simpler subroutines, achieving stability through modular coherence. The properties of an atom emerge from the topological arrangement of constituent patterns and the relational dynamics between them, which are governed by the I_R between constituent patterns and the underlying **Cosmic Algorithm** rules and proto-properties.

20.2 **Complex systems**
Exhibit emergent properties not present in their parts. In *autaxys*, these emerge from the complex network of relations and feedback loops that establish *higher-order ontological closure*. The behavior of a cell or an ecosystem is a manifestation of its high *C* (complexity), unique *T* (structure/organization), and the dynamic processes maintaining its high *S* (stability/resilience) in a changing environment. These systems are intricate, dynamic computations achieving closure at multiple nested levels. They are *self-organizing computational systems* whose emergent behavior is a consequence of their complex relational structure and the drive to maintain stability, utilizing higher-level *S* mechanisms (S_5, S_6). The emergence of life is a transition to a new level of self-sustaining, adaptive *ontological closure* (S_5/S_6), enabled by specific proto-properties that facilitate complex biological structures and their interactions. Life is a pattern that actively computes its own persistence against environmental flux, using internal error-correction and adaptive mechanisms.

20.3 **Consciousness** `(Speculative Extension)`
Speculatively, consciousness could be understood as an extremely high-order, complex, and dynamic form of *self-referential ontological closure* (S_7). It might involve intricate, nested feedback loops within the relational network of a brain (a high-*C*, high-*T* composite pattern), creating a stable, unified pattern of subjective experience. The depth and richness of consciousness could relate to the *C* (complexity), the specific recursive and dynamic *S* mechanisms (S_2, S_3, S_4, S_5, S_6, S_7+ levels) involved in this neural-relational pattern, and its ability to form self-referential loops that include representations of its own processing state. It represents the universe's relational processing achieving a unique level of self-awareness and unified perspective through a highly organized, self-validating, and dynamically stable structure. It is a pattern that maintains coherence by reflecting upon its own process of coherence. The mechanism involves internal relational structures that model or simulate the pattern's own state and its relationship to the principles of *ontological closure* and the Cosmic Algorithm, using this internal model to reinforce its own stability. It is a truth statement that understands and asserts its own truth. It requires extremely high *C* and complex *T* structures capable of internal representation and *meta-cognition* using the rules of the *relational calculus*, enabled by specific proto-properties that allow for such complex self-referential structures. This level of closure may also be where the organized *proto-qualia* associated with the constituent D's and R's give rise to unified subjective experience and *qualia harmonics*—the “feel” of existing and processing information, the rich, complex blend of fundamental subjective tones.

21.0 Relational Defects: Stable Anomalies in the Network

Beyond the stable patterns (*P_ID*s) that achieve *ontological closure*, the *autaxys* framework also allows for persistent or *meta-stable* anomalies in the fundamental relational network (S_0) itself. These are *relational defects*: configurations of D's and R's that do not form self-contained patterns with defined AQNs in the usual sense, but represent topological irregularities or persistent tensions in the vacuum ground state. Their formation and stability are governed by the rules of the **Cosmic Algorithm** and the *proto-properties* of D and R, representing alternative stable configurations *within* the S_0 state dynamics that do not achieve full *ontological closure* as independent patterns. They are stable knots of unresolved *relational tension*, deviations from the ideal coherent structure.

21.1 **Nature of defects**
Relational defects are deviations from the homogeneous, fluctuating texture of the *vacuum state* (S_0). They are persistent structural features in the

fundamental D/R graph that represent localized regions where the rules of the **Cosmic Algorithm** lead to a stable, but not fully closed or self-consistent, configuration. They are topological anomalies in the *quantum relational foam* that resist dissolution. Their stability (S_{defect}) arises from their specific topological structure (T_{defect}) and the *proto-properties* of the D's and R's forming them, which make them immune to the standard *resolution/cancellation rules* that dissolve unstable patterns. They are like knots or twists in the relational fabric that cannot be untangled by the normal dynamics. They represent localized regions of persistent *relational tension*. They are 'errors' or 'inconsistencies' in the cosmic computation that have become stable features of the background substrate, perhaps due to specific combinations of proto-properties that create irreducible relational conflicts that cannot be resolved by any available rule. They are stable *logical paradoxes* embedded in the network.

21.2 **Types of defects**

Analogous to topological defects in condensed matter physics or cosmology, *relational defects* could come in various forms, determined by the specific unresolved topological configuration and the *proto-properties* involved:

21.2.1 **Point Defects:** Localized anomalies in the connectivity or *proto-property* distribution of a single D or R within S_0 that cannot be resolved by the *resolution/cancellation rules* due to specific proto-property conflicts or topological constraints. Could manifest as localized 'charges' or sources of *relational stress*.

21.2.2 **Line Defects (e.g., cosmic strings):** One-dimensional structures in the relational network representing persistent linear regions of unresolved tension or topological irregularity. They could be formed during the rapid phase transition of **Cosmic Genesis**, perhaps as boundaries between regions where different sets of fundamental rules or *proto-property* biases initially dominated. Their properties (C_{defect}, T_{defect}, S_{defect}, $I_{R,defect}$) would be determined by the specific D/R configurations and proto-properties forming the line and the rules governing their persistence. Could manifest as *cosmic strings*, with observable gravitational effects (e.g., lensing, gravitational waves) and potential influence on the vacuum texture around them. Their $I_{R,defect}$ could involve subtle biasing of local D/R dynamics or interaction probabilities for patterns in their vicinity, potentially influencing galaxy formation or other large-scale structures.

21.2.3 **Surface Defects (e.g., domain walls):** Two-dimensional structures representing boundaries in the relational network where different local configurations or even different effective sets of rules or *proto-property* biases meet, creating a stable wall of tension or inconsistency. Could manifest as *domain walls*, with potentially significant mass/energy density (C_{defect}) and gravitational effects. Their stability (S_{defect}) would depend on the robustness of the boundary configuration against the *resolution rules*. They represent stable interfaces between different computational “phases” of the vacuum.

21.2.4 **Volume Defects:** Three-dimensional regions with persistent anomalous relational structure. These could be more complex, localized regions of highly irregular or inconsistent relational configurations that resist dissolution.

21.3 **Properties and influence**

Relational defects would possess properties derived from their structure (C_{defect}, T_{defect}, S_{defect}, $I_{R,defect}$).

21.3.1 C_{defect}: Would represent the complexity of the anomalous relational structure, contributing to mass/energy density. This mass is not from a stable, self-contained pattern but from the persistent, unresolved relational activity/tension within the defect structure.

21.3.2 T_{defect}: Their specific topological type (T_{defect}) (e.g., line, surface) and internal structure – the specific configuration of D's and R's and their *proto-properties* that forms the stable anomaly.

21.3.3 S_{defect}: Their stability (S_{defect}), indicating how resistant they are to being resolved by the **Cosmic Algorithm**. By definition, stable defects have high S_{defect}. This stability is different from pattern stability; it is the stability of an unresolved state, a form of persistent non-closure that is nonetheless fixed in the network.

21.3.4 $I_{R,defect}$: How they interact with stable patterns (*P_ID*s) and the vacuum (S_0). They would influence the local texture of S_0, biasing rule application and

pattern formation in their vicinity, potentially through their persistent *relational tension* or their specific proto-property distribution. They could act as gravitational sources (due to C_{defect}), scatter particles, or influence phase transitions. Their $I_{R,defect}$ could involve specific rules for how they interact with the *proto-properties* of D's and R's in S_0, or how they affect the local application of the *quantum rule* or *formation rules*. They are persistent environmental factors that shape the dynamics of the relational network.

21.4 **Origin**
Relational defects likely formed during the tumultuous phase transition of **Cosmic Genesis**, when the universe transitioned from a state of maximal potentiality (S_0) to the emergence of stable patterns. Incomplete or frustrated attempts at achieving *ontological closure* across the rapidly expanding network could have left behind persistent topological scars—regions where the drive for coherence failed to resolve local inconsistencies, resulting in stable anomalies. The type and density of defects would be determined by the specific dynamics of this phase transition, the rates of rule application, and the details of the **Cosmic Algorithm** and *proto-properties*, particularly those proto-properties that might lead to irreducible conflicts or frustrated configurations.

21.5 **Physical manifestations**
Relational defects could be candidates for explaining certain cosmological phenomena not fully accounted for by the Standard Model, such as non-particle dark matter (defects with high C_{defect} but weak $I_{R,defect}$ with baryonic matter). They might provide alternative explanations for cosmic structures or anomalies, or contribute to the overall energy density of the universe (e.g., *domain walls* contributing to dark energy). *Cosmic strings* and *domain walls* are classic examples of topological defects hypothesized in other theories, which find a natural interpretation as stable *relational defects* in *autaxys*. Their detection would provide strong evidence for the underlying relational structure of reality and the nature of the cosmic phase transition. They represent a distinct class of stable structures in the universe, different from patterns (*P_ID*s).

21.6 **Relational tension and defects**
Relational defects are inherently linked to *relational tension*. They are regions where the fundamental drive towards coherence is locally frustrated, leading to a stable, but tense, configuration. The presence of defects increases the overall *relational tension* in the vacuum (S_0), potentially influencing the large-scale dynamics of the universe (e.g., contributing to dark energy) or driving *algorithmic self-modification* `(Speculative Extension)` over cosmic time (e.g., rules that resolve tension might be favored). They are stable knots of *logical inconsistency* within the network. Their very existence is a form of persistent *logical dissonance* in the cosmic harmony, yet they are stable features of the landscape.

21.7 **Relational ecology (revisited)**
Relational defects are part of the *relational ecology*, acting as persistent environmental features that influence the formation, distribution, and interaction of stable patterns. They can act as gravitational anchors for large-scale structure formation, or their local S_0 texture biases ($I_{R,defect}$) can influence local pattern emergence rates or types. They are the “terrain” upon which the ecological interactions between patterns occur.

22.0 Scale and Emergence: The Layered Universe

The *autaxys* framework describes reality from the fundamental level of D's and R's to emergent macroscopic phenomena. This involves different levels of description and corresponding emergent laws, depending on the scale and the complexity of the patterns involved.

22.1 **Fundamental layer (Planck scale)**
The realm of fundamental *distinctions* (D) and *relations* (R) with their *proto-properties*, governed by the **Cosmic Algorithm** (*relational calculus*), exhibiting the properties of the *quantum relational foam* (S_0), *relational noise*, *relational tension*, and *fundamental uncertainty*. This is where the probabilistic nature of

the *quantum rule* is most evident, and dynamics are *non-commutative*. This level is described by the *relational calculus*. Phenomena at this scale are dominated by the direct dynamics of D's and R's and their proto-properties, before stable patterns have formed or their collective behavior emerges. This is the realm of pure relational processing.

22.2 **Particle layer (electroweak scale and below)**
The realm of stable patterns (*P_ID*s) of S_1 to S_4 levels (fundamental particles, composite particles, atoms), characterized by their AQNs (*C*, *T*, *S*, I_R). Dynamics are governed by the I_R (emergent forces) and the probabilistic rules of Quantum Mechanics (derived from the *quantum rule* and S_0 dynamics). This level is described by Quantum Mechanics (derived from the *relational calculus*), incorporating **the Autaxic Table of Patterns** as the fundamental particle spectrum. Quantum phenomena like superposition, entanglement, and tunneling are key features, arising from the underlying probabilistic and non-local nature of the *relational calculus* operating on the S_0 foam. The laws of Quantum Mechanics are emergent statistical or effective rules describing the behavior of stable patterns and their interactions, derived from the fundamental rules and proto-properties.

22.3 **Macroscopic layer (classical scale)**
The realm of large-scale composite patterns (molecules, objects, systems) with high *S* (S_5+) and vast collections of lower-*S* patterns, where the collective behavior of vast numbers of constituent patterns and interactions averages out the underlying quantum probabilistic fluctuations and individual relational dynamics. Dynamics are described by classical physics (Newtonian mechanics, General Relativity, classical thermodynamics). Classical laws emerge from the statistical behavior of the underlying quantum patterns and the large-scale structure of the emergent spacetime network. Gravity, for example, emerges as a large-scale structural property of spacetime geometry, which is influenced by the collective *C* of massive patterns. Macroscopic properties like temperature and pressure emerge from the collective relational activity and tension of constituent patterns (*relational thermodynamics*). The arrow of time becomes clearly defined by the statistical increase in *relational entropy* (S_{rel}). This level of description is an effective theory, providing a simplified but accurate model of behavior at large scales, where the individual quantum and relational details are averaged out. The transition from quantum to classical is the process of decoherence and the statistical averaging of probabilistic outcomes across vast numbers of fundamental computational steps.

22.4 **Higher-order layers (biological, cognitive, conscious)**
Realms of increasingly complex and dynamic patterns (S_5, S_6, S_7) exhibiting sophisticated forms of *ontological closure* (*environmental meta-stability*, *error-correcting/adaptive closure*, *self-aware/reflexive closure*). These layers have their own emergent properties and dynamics (e.g., biological processes, neural activity, subjective experience) that require different descriptive frameworks (e.g., biology, neuroscience, potentially a new science of consciousness) built upon the underlying physics. These are the realms where *relational ecology* and *relational catalysis* become highly relevant. *Qualia harmonics* `(Speculative Extension)` emerge at the S_7 level. The laws and principles governing these layers are emergent properties of the specific, complex relational structures and dynamics that arise at these scales, not fundamental laws of the universe. They are the emergent “rules of operation” for highly complex, self-organizing systems built from fundamental patterns.

22.5 **The problem of emergence**
A key challenge is rigorously demonstrating how the laws and phenomena of each higher layer emerge from the principles and dynamics of the layer below it, starting from the fundamental *relational calculus* and *proto-properties*. How does the *quantum rule* of the **Cosmic Algorithm** lead to the specific probabilities observed in Quantum Mechanics? How does the collective behavior of high-*C* patterns deform the relational network to produce the precise geometry of spacetime described by General Relativity? How do organized *proto-qualia* `(Speculative Extension)` combine to form unified subjective experience? This involves bridging the gap between different levels of description and demonstrating that the emergent laws are consistent with observations at their respective scales. The complexity (*C*) of a pattern or system plays a crucial role in determining which level of description is appropriate.

This requires developing formal mathematical methods to derive emergent theories from the fundamental *relational calculus*. It is the problem of deriving the macroscopic universe from its microscopic computational substrate.

23.0 Potential Novel Patterns: Exploring the Autaxic Table's Gaps

The Autaxic Table of Patterns, as a map of the phase space of stable relational configurations, inherently predicts the existence of stable patterns (*P_ID*s) that are logically permitted by the **Cosmic Algorithm** and *proto-properties* but may not yet be observed. These “gaps” in the table represent potential new particles or phenomena. By exploring the possible combinations of **Autaxic Quantum Numbers** (*C*, *T*, *S*, I_R) derivable from the fundamental rules and *proto-properties*, *autaxys* can make concrete predictions for novel entities.

23.1 **The *auton* (P_{auton}): a hypothetical example**
Based on the framework, we can speculate on a pattern distinct from the Standard Model.

The generative logic for such a pattern, named the *auton*, would proceed as follows: The *Autaxic Generative Engine* would be tasked with finding stable solutions in the high-complexity (*C*) regime. The *auton* is hypothesized to be a specific solution where a combination of D's with high *proto-valence* and R's with specific *proto-interaction channel types* can only achieve a stable topological closure (*T*) above a certain threshold of complexity. This required *T* would be one that internally balances all *proto-polarities*, resulting in a neutral pattern, while its recursive structure grants it an error-correcting stability mechanism (S_6). The external 'surface' of this topology would lack the features necessary to satisfy the *I_R* for Standard Model forces, but its high internal relational density (*C*) would heavily influence the local geometry (gravity) and subtly bias the S_0 dynamics, leading to its unique 'Catalytic Closure' interaction rule. Its predicted properties are therefore:

23.1.1 *P_ID*: P_{auton}
23.1.2 *C*: Very high (more massive than a Top Quark). This suggests it is a complex, densely organized relational structure, requiring significant internal processing to maintain its *ontological closure*. Its high *C* arises from a specific intricate *T* structure built from a large number of D's and R's with compatible *proto-properties*, where this complexity is the minimal requirement for achieving its unique high *S* mechanism. Its existence at this high *C* implies a specific configuration of constituent proto-properties and rules that allows for such dense packing of relational activity while maintaining coherence, potentially representing a highly efficient form of relational computation (high *S*/*C* for its complexity class).
23.1.3 *T*: A complex, non-scalar topology (Spin ≠ 0) with internal symmetry that allows it to exist in two stable, interconverting states with subtly different external relational interfaces (I_R), but *no* net charge or other Standard Model fundamental charges. This implies its internal relational graph structure has specific topological features (e.g., loops, knots, connectivity patterns) that are distinct from known particles, potentially involving a novel combination of *proto-properties* or a unique way of satisfying the *symmetry preference rule*. The existence of two interconverting states suggests a form of S_3 *dynamic equilibrium* at a sub-level within its overall high *S*, a stable limit cycle between topologically similar forms allowed by specific *transformation rules* and *proto-properties*. Its neutrality suggests its constituent proto-polarities are perfectly balanced within its complex structure, adhering to a specific aspect of the *symmetry preference rule* at the composite level. The specific spin value would arise from its internal relational flow (*T*) and the proto-properties of its constituents.
23.1.4 *S*: Extremely high, achieved through a novel S_5/S_6/S_7 mechanism involving nested recursive self-validation, environmental interaction feedback, and potentially even a rudimentary form of error-correcting self-modeling, making it effectively immortal in isolation within a stable environment. This high *S* is a consequence of its specific high *C* and complex *T*, representing a very deep attractor basin in the phase space. Its mechanism involves sophisticated internal error correction and resilience against *relational noise* (S_6), dynamic coupling with the *vacuum state* (S_0) or other pervasive fields (S_5), perhaps leveraging specific *proto-coherence potential* properties of its constituents or novel *validation/closure rule* applications. Given its complexity, it might even

approach S_7 levels, exhibiting a form of internal *meta-stability* through self-monitoring, but without the *qualia harmonics* of consciousness. Its stability is a testament to its efficiency in maintaining OC despite its high complexity (high *S*/*C* ratio, favored by *economy of existence* `(Guiding Principle)`). It represents a highly successful strategy for persistent existence in the cosmic ecology.
23.1.5 I_R: Primarily interacts via gravity (due to high *C*, as a consequence of its impact on spacetime geometry). Its unique 'Catalytic Closure' rule defines its non-gravitational interactions. The 'Catalytic Closure' rule allows it to temporarily interact with low-*S* patterns (e.g., virtual particles or vacuum fluctuations, S_0), facilitating *their* transient closure in its vicinity without itself changing state or being consumed. This interaction slightly alters the local relational network density or biases the local application of *genesis*/*formation rules* for transient D's/R's, creating a subtle, non-gravitational influence radius. This rule is a specific application of the *composition* or *transformation rules* of the **Cosmic Algorithm**, enabled by the *auton*'s unique *T* and constituent *proto-properties* (e.g., specific *proto-interaction channel types* or *proto-coherence potential* combinations), allowing it to form transient, unstable composites with S_0 elements in a way that facilitates *their* closure dynamics. It acts like a 'relational enzyme', lowering the activation energy for certain relational processes in its local environment. This interaction could potentially involve leveraging the inherent *relational tension* in S_0. The *auton*'s high *C* and *S* allow it to maintain its own closure while transiently organizing the local S_0 dynamics.

23.2 **Predicted behavior (*auton*)**
An *auton* would be a supermassive, stable, neutral pattern that is hard to detect directly via Standard Model forces (EM, Strong, Weak) because its I_R for these forces are zero or negligible due to its neutral proto-property balance and specific *T*. Its high *C* provides significant gravitational influence on large scales. Its unique 'Catalytic Closure' interaction could explain certain dark matter phenomena – its high *C* provides gravitational influence, and its 'Catalytic Closure' interaction could subtly affect the dynamics of baryonic matter or light in its proximity (e.g., altering local vacuum properties, influencing the formation/decay of virtual particles involved in other interactions, or subtly biasing the *quantum rule* outcomes for other patterns in its vicinity), potentially explaining anomalies attributed to dark forces or specific dark matter detection attempts that look for non-gravitational dark matter interactions. Its high *S* explains its stability over cosmological timescales, making it a viable dark matter candidate. The two interconverting *T* states (S_3 sub-level) might lead to subtle, low-frequency oscillations in its local influence field or interaction cross-section, potentially detectable with highly sensitive experiments. The existence and properties of the *auton* would be a direct prediction of a specific point in the *autaxic table* phase space, derivable from the fundamental D/R rules and *proto-properties* if the framework is correct. Its discovery would provide crucial evidence for the generative power of *autaxys* and the existence of novel *S* levels and interaction mechanisms beyond the Standard Model. The *auton* represents a distinct solution to the OC problem in a high-*C* regime, favored by the *economy of existence* due to its high *S*/*C* ratio despite its mass. Its existence would suggest that the landscape of stable patterns is richer and more complex than currently understood.

23.3 **Other hypothetical novel patterns**
(This section remains the same as v1.8, but is now understood as a list of conceptual possibilities pending derivation.)

23.4 **General predictive strategy:** The process of predicting novel patterns involves:
23.4.1 Formalizing the D/R rules and the set of D/R *proto-properties* within the *relational calculus*[1].
23.4.2 Using the *relational calculus* to computationally explore the space of possible D/R configurations that satisfy the *ontological closure* condition (*validation/closure rule*).
23.4.3 Classifying the resulting stable configurations by their derived AQNs (*C*, *T*, *S*, I_R).
23.4.4 Comparing the resulting catalogue of stable patterns to the known particles of the Standard Model.

23.4.5 Identifying any derived patterns that do not correspond to known particles—these are the novel predictions. Their predicted AQNs define their fundamental properties and potential interactions.

24.0 Potential Novel Predictions and Testable Implications:

Autaxys suggests areas for novel predictions grounded in its core principles, providing concrete avenues for experimental and observational tests:

24.1 **Granularity of spacetime and relational network structure:** *h* and *c* imply a discrete relational graph at Planck scale. This discreteness should have observable consequences distinct from smooth spacetime or other quantization approaches. Testable predictions could involve photon/gravitational wave dispersion relations (speed might subtly depend on frequency/wavelength at extreme energies, reflecting propagation across discrete links), cosmic ray shower anisotropies reflecting the underlying network structure, or specific patterns in the Cosmic Microwave Background reflecting the structure of the primordial relational network. The quantization of gravity is inherent in the network discreteness itself, not requiring a graviton particle. This discreteness might also affect the behavior of particles at extremely high energies or in extreme gravitational environments, potentially leading to deviations from GR or QFT predictions. Experiments probing the fundamental structure of spacetime at the smallest scales could provide evidence for the underlying relational network, potentially revealing its characteristic grain or texture, influenced by *proto-properties*.

24.2 **Catalogue of stable patterns:** The *Autaxic Generative Engine*², once formalized, predicts a specific, finite catalogue of possible stable patterns (*P_ID*s) based on the fundamental rules of D/R interaction and *ontological closure*. This catalogue should include known Standard Model particles *and* predict novel stable or *meta-stable* patterns with defined *C*, *T*, *S*, I_R properties (e.g., mass, charge, spin, lifetime, interactions). These novel patterns could be dark matter candidates, explain observed anomalies (e.g., muon g-2, proton radius puzzle, anomalous scattering events), or require experimental searches for particles with predicted properties at future colliders or through astrophysical observations. The structure of the populated **Autaxic Table** itself is a set of predictions waiting to be derived from first principles. Discovering a particle with properties that precisely match a predicted *P_ID* from the generative engine would be strong evidence for the framework.

24.3 **Exotic interaction rules and proto-property signatures:** The framework predicts novel I_R based on topological compatibility (*T*) and *proto-property* compatibility between patterns, potentially explaining interactions not described by the Standard Model forces, such as dark matter interactions with baryonic matter (*relational catalysis*) or specific, rare decay modes. These rules are derived from pattern structure and *proto-properties*, not postulated arbitrarily. The search for 'dark forces', unexpected decay pathways, or subtle deviations in interaction strengths based on specific pattern types could test these predictions and provide insight into the underlying *proto-properties* of D and R. Measuring the precise values of coupling constants might reveal relationships or ratios that can be derived from the proto-properties and rules.

24.4 **Non-local correlation properties and entanglement limits:** Implications for entanglement robustness under extreme conditions (e.g., high gravity, high energy density). *Autaxys* might predict limits on the 'span' or 'complexity' of a coherent non-local pattern based on the structure of the underlying relational graph or the computational cost (*C* in terms of required processing power to maintain the entangled state) relative to its stability (*S*). Deviations from expected entanglement decay or fidelity based purely on emergent spacetime distance could probe the underlying relational structure and the nature of non-local relational links, potentially influenced by *proto-properties*. Experiments involving entanglement across vast distances or in strong gravitational fields could be relevant.

24.5 **Cosmological signatures of genesis and defects:** The early universe state as maximal relational activity potential and the **Big Bang** as a phase transition to stable pattern emergence could leave specific signatures. Expansion might be driven by the network structuring towards global coherence. The

zero-point energy link to the cosmological constant provides a potential explanation for dark energy rooted in the vacuum's inherent relational activity. Potential observational signatures in large-scale structure formation or early universe fluctuations distinct from standard inflationary models, perhaps reflecting the initial conditions, the dynamics of the phase transition, the formation of *relational defects*, or fundamental symmetries/asymmetries of the relational rules and *proto-properties*. The existence and properties of *relational defects* (*cosmic strings*, *domain walls*, textures) are direct predictions, potentially observable through gravitational lensing, CMB anisotropies, or Gravitational Wave signals. Their properties (e.g., tension, distribution) would be derived from the **Cosmic Algorithm** and *proto-properties*. The *multiverse* prediction `(Speculative Extension)` is conceptually testable only through its implications for *our* universe's fundamental constants and rules, if those are seen as drawn from an ensemble or resulting from a selection process.

24.6 **Computational limits and black holes:** The framework suggests fundamental limits on information processing or complexity (*C*) within localized regions of the relational network. This could link to the black hole information paradox from a computational perspective – a black hole represents a region of maximally dense relational processing where the ability to distinguish and relate (D and R) reaches a limit, potentially leading to a loss of specific pattern information. The Bekenstein bound could be reinterpreted as a limit on the maximum *C* density a region of the relational graph can sustain before undergoing a phase transition (e.g., like forming a black hole, a region of maximally dense, perhaps simplified, relational processing). Predictions might relate to the thermodynamics of black holes, information escape mechanisms, or deviations from standard black hole evaporation theories, suggesting a link between gravitational collapse and computational limits in the relational network. The properties of black holes (S_{rel}, T_{rel}) might be derivable from the properties of the *relational defects* or highly-dense S_0 configurations that constitute them.

24.7 **Signatures of relational aesthetics and economy of existence:** If the fundamental rules are driven by `(Guiding Principles)` of *logical elegance* or coherence, could this leave subtle, non-obvious patterns in the distribution of fundamental constants, particle masses, or interaction strengths? This is highly speculative but suggests searching for mathematical “beauty” or patterns in the outputs of the generative process (**the Autaxic Table**). Are there unexpected mathematical relationships between pattern properties that point to an underlying optimization principle? Testing would involve comparing the derived properties from the formalized generative engine (potentially biased by aesthetic/economy principles) against experimental data.

24.8 **Probing relational memory and catalysis:** Could there be phenomena that allow direct probing of the underlying relational graph, bypassing the emergent spacetime metric, revealing its history or its capacity to influence processes? Perhaps specific high-energy interactions or gravitational effects that reveal the discrete, networked nature of reality rather than its smooth, continuous approximation. Analogies from condensed matter physics where macroscopic properties emerge from a microscopic lattice might provide insights. Experiments looking for non-linear or non-local effects in vacuum under extreme conditions, or subtle biases in reaction rates or decay outcomes near massive objects or predicted *relational defects*, could be relevant to testing the concepts of *relational memory* and *relational catalysis*.

24.9 **Variations in fundamental constants and algorithmic self-modification:** If the **Cosmic Algorithm** undergoes subtle *algorithmic self-modification* `(Speculative Extension)`, fundamental constants might not be truly constant but could vary slightly over cosmic time or even space. Detecting such variations through precision measurements of distant astrophysical phenomena (e.g., quasar spectra, Oklo phenomenon) could provide evidence for dynamic rules. The pattern of variation might reveal insights into the principles (*relational aesthetics*, *economy of existence*) guiding the algorithmic evolution and the influence of *proto-properties*.

25.0 Conclusion: The Universe as a Self-Programming, Meaning-Generating Computation

The Autaxic Table of Patterns, grounded in the `(Core Postulate)` of *ontological closure* and defined by intrinsic **Autaxic Quantum Numbers**, provides a powerful, unified, and *generative* framework rooted in fundamental relational processing. It proposes an explanation for fundamental particles, interactions, spacetime, and cosmology not as brute facts or axiomatic entities, but as emergent consequences of stable, self-consistent relational structures forming within a dynamic, self-organizing computational substrate. This approach aims for a predictive theory deriving reality from minimal generative principles – the fundamental D/R primitives with their inherent *proto-properties* and the **Cosmic Algorithm** rules governing their interaction, potentially guided by `(Guiding Principles)` like *relational aesthetics* (seeking *relational harmony*) and the *economy of existence* (seeking maximal *S*/*C* ratio and minimal *relational tension*).

The universe is viewed as a vast, massively parallel *relational computation* that is inherently self-organizing and, in a `(Speculative Extension)`, potentially *algorithmic self-modifying*. It constantly explores the landscape of *logical possibility* (the *autaxic phase space*) and actualizes configurations that achieve *ontological closure*. Physical properties, forces, gravity, and the geometry of spacetime are proposed to be emergent features of this computational process. Quantum phenomena find interpretation in the probabilistic nature of the vacuum (S_0) and the dynamics of patterns seeking resolution from potential states.

Higher-order structures, from atoms to complex biological systems and even consciousness (S_7), are understood as layered forms of *ontological closure*. Consciousness, speculatively, represents an extremely high-order, self-referential form of closure, potentially experiencing the *proto-qualia* of the fundamental primitives and the *qualia harmonics* of their structured combinations.

By shifting the focus from 'what things are made of' to 'how things relate and stabilize', *autaxys* offers a fresh perspective on the deepest questions of physics. While significant challenges remain in formalizing the framework (developing the *relational calculus*[1]) and rigorously deriving specific predictions, its potential to unify seemingly disparate phenomena under a single generative principle makes it a compelling direction for fundamental research. It suggests a universe that is not just a collection of particles following pre-set laws, but a dynamic, self-programming, meaning-generating computation, constantly creating reality from potential through the fundamental logic of relational coherence and self-consistency.

Footnotes:

[1] The development of *autaxys* is an ongoing research program, which rigorously builds the theory in layers from abstract logical axioms (Layer 0) to concrete mathematical formalisms (Layer 2) and computational models. This methodology, informed by lessons from prior foundational research projects (e.g., Infomatics, Information Dynamics, Logically Consistent Reality Framework, Principle-Based Research Framework), explicitly addresses the “stable emergent particle problem” and the “formalism gap” encountered in earlier attempts to derive complex emergent structures from fundamental principles. The goal is to ensure that the framework's assertions are grounded in a testable and consistent mathematical foundation.

[2] The *Autaxic Generative Engine* refers to the specific, mathematically defined set of coupled update equations that govern the dynamic graph in our Layer 2 formalism (e.g., the “Dynamic Causal Influence Network” or DCIN, which defines how node states, persistence, and edge weights evolve). This engine is the computational instantiation of the Cosmic Algorithm and its principles.

Appendix A: Glossary of Key Terms

- **Autaxic Quantum Numbers (AQNs):** The set of derived properties of a stable pattern that define its identity and behavior. The core AQNs are:
  - **C (Complexity):** The pattern's structural intricacy and internal processing load; the proposed origin of mass and energy.
  - **T (Topology):** The pattern's internal relational "shape," symmetry, and asymmetry; the proposed origin of charge, spin, and particle family.
  - **S (Stability Index):** The pattern's resilience and coherence; a measure of the robustness of its ontological closure.
  - **I_R (Interaction Rules):** The "grammar" derived from a pattern's topology (T) defining how it can coherently interact with other patterns.
- **Cosmic Algorithm:** The fundamental, self-organizing set of rules governing how distinctions and relations combine, transform, and resolve. It is the "operating system" of reality.
- **Distinction (D) / Relation (R):** The two fundamental primitives of reality `(Core Postulate)`. D is the act of differentiation (a "noun"); R is the act of connection or transformation (a "verb").
- **Ontological Closure (OC):** The core principle of the framework `(Core Postulate)`. The state where a relational pattern is self-consistent, self-referential, and can sustain its own existence autonomously. It is the cosmic filter that determines what can exist.
- **Proto-properties:** The inherent, fundamental attributes of D's and R's (e.g., *proto-polarity*, *proto-valence*) that are not emergent. They bias the behavior of the primitives and seed the diversity of the universe `(Core Postulate)`.
- **Relational Aesthetics / Economy of Existence:** `(Guiding Principles)` Hypothesized meta-principles that may guide the Cosmic Algorithm, favoring the formation of elegant, symmetric, and efficient (high S/C ratio) patterns.
- **Relational Tension:** A measure of unresolved logical inconsistency, incoherence, or disorder in the relational network. The drive for OC is a drive to minimize this tension.
- **S-Levels (S_0-S_8):** A classification of the different mechanisms and complexities of ontological closure, from the potential of the vacuum (S_0) to simple recursive patterns (S_2), composite structures (S_4), adaptive life (S_6), and speculative self-aware consciousness (S_7).
- **Vacuum State (S_0):** The ground state of the universe, understood not as empty space but as a dynamic, fluctuating network of potential distinctions and relations (a "quantum relational foam") that have not achieved stable ontological closure.