At the Limit of Distinction

Measurement, Semantic Agency and the Construction of the Quantum World within Finite Symbolic Mechanics

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Abstract

This monograph reconsiders the measured world conventionally organised under quantum mechanics from within the commitments of Finite Symbolic Mechanics and Finite Symbolic Dynamics. It begins with a restrained proposition: whatever may occur before measurement, an event enters the scientific record only when an interaction produces a physically instantiated distinction. If the lowest available measurement is registered as a step between distinguishable states, then the scientifically available world must ultimately be composed from finite, stepwise registrations. This proposition does not establish that the unresolved world is intrinsically discrete. It establishes the form in which that world can become symbolically available to a measuring community.

The argument follows the trajectory from interaction to apparatus change, from apparatus change to encoded datum, from datum to model-defined observable, and from observable to the named entities that this work calls *semantic agents*. An electron, charge, mass, spin or quantum state may begin as a compact means of organising recurrent registrations, yet scientific grammar subsequently permits the named construction to become a bearer of properties and the subject of causal verbs. The semantic agent is then allowed to explain the observations from which it was inferred. The monograph does not begin by denying the utility or possible physical reference of these agents. It asks how their agency was acquired, which measurement distinctions sustain their separability, and what provenance is lost when their inferential history is compressed.

The Stern–Gerlach experiment is developed as a central provenance study. The primary registration is treated as a finite spatial distribution produced by a complete experimental arrangement rather than as the direct sight of an exact fractional property. The familiar passage from two outcome regions to spin-$\frac{1}{2}$ is reconstructed as a chain of measurement, classification, mathematical representation and semantic promotion. This analysis leads to a further distinction between spatial resolution, positional precision and model-relative accuracy. It also motivates a provisional Greene–Pascal Limit, defined as the boundary beyond which continued symbolic decomposition no longer corresponds to independently sustained physical distinctions and depends increasingly upon reconstruction and semantic separation.

The Greene–Pascal Limit is kept distinct from the Alphonic Limit. The former is initially treated as an instrument-, model- and consensus-dependent boundary, whereas the latter concerns the proposed minimum physical extent at which a distinction can be instantiated, preserved and admitted as a symbol. Their eventual identity is neither assumed nor excluded. By leaving the relationship open, the monograph provides a framework in which later measurement, conceptual refinement and empirical work may show whether the two

terms converge or continue to describe different boundaries.

Preface: The Need to Refine the Language

This study arises from a longer investigation into the finite symbol, the generonic boundary, physical extent, uncertainty, provenance and admissibility. Those ideas already implied that the measured world could not be identical to an unmediated world existing outside the measurement process, because every scientific account must pass through a finite physical interaction and then through a finite symbolic registration. What remained insufficiently articulated was the transformation by which a regularity within a body of measurements becomes a named object and then acquires apparent causal independence within the explanatory language of science.

The term *semantic agent* is introduced to make that transformation visible. It does not mean that scientific entities are merely words or that physical interactions are arbitrary products of language. It identifies the representational moment at which a named model component begins to perform explanatory work. When an account says that an electron moves, a charge interacts, a spin couples, a wavefunction collapses or a field fluctuates, a noun has become the subject of a verb. The noun may preserve important regularities, but its grammatical agency can conceal the chain by which it was constructed from extended apparatus interactions, thresholded registrations, encoding practices and communal rules of admissibility.

This monograph therefore does not attempt an immediate replacement theory for quantum mechanics. Nor does it begin with a verdict concerning the reality or unreality of electrons, spin, fields or states. Its first task is more elementary and, for that reason, more foundational. It reconstructs the path along which these entities enter the symbolic world, identifies the commitments added at successive stages, and asks where the continued refinement of the model outruns the independently sustained distinctions of the instrument.

The terminology is deliberately allowed to remain provisional where the conceptual landscape has not yet stabilised. In particular, the Greene–Pascal Limit and the Alphonic Limit may eventually prove to be two descriptions of one boundary, or they may remain distinct because they approach the problem from different sides. The Greene–Pascal Limit presently describes a failure of continued measured decomposition, whereas the Alphonic Limit describes the proposed minimum physical-symbolic distinction itself. The decision to preserve both terms is not indecision but methodological restraint. The language should be permitted to differentiate the territory before it is compressed.

Contents

Part I

The Measured World Begins with a Distinction

Chapter 1

The Step at the Generonic Boundary

Any scientific observation requires a physical change that can be distinguished from the absence of that change. The measuring system may emit a pulse, darken a grain, alter a voltage, change a stored state, displace a pointer or create a visible mark, but in every case a difference must be made sufficiently stable to enter a record. The elementary empirical event is consequently not possession of the unresolved world itself. It is a transition within a registering system.

At the lowest level of symbolic admission, this transition has the following form, which records only the passage into an admissible state and does not yet describe the unresolved source.

$$\text{state not registered} \longrightarrow \text{state registered}. \tag{1.1}$$

This is a step function at the level of measurement. The statement is intentionally limited. It does not prove that the source of the registration was intrinsically stepwise, nor does it prove that the pre-measurement world is built from indivisible digital states. The step may arise from a detector threshold, a physical metastability, an encoding convention, a finite storage process or a conjunction of these. What can be said is that a transition must become distinguishable before it can enter the scientific symbolic stream.

The distinction can be stated compactly in the following expression, which preserves the separation between a measurement condition and an ontological conclusion.

$$\text{stepwise measurability} \not\Rightarrow \text{stepwise ontology}. \tag{1.2}$$

The force of this inequality is methodological. It prevents the form of the detector output from being silently attributed to the unresolved source. If an apparatus returns discrete clicks, marks or classified outcomes, science is entitled to describe those registered distinctions. A further claim that the world consists of corresponding discrete objects requires an additional inferential trajectory. Without that additional trajectory, the measurement architecture has been mistaken for the independently existing organisation of the measured world.

Finite Symbolic Mechanics places the generonic boundary at the passage where an unresolved interaction produces a registrable physical distinction. A simplified trajectory may be written in the following form so that operations usually compressed into the word ‘measurement’ remain separately visible.

$$\widetilde{\mathcal{W}} \xrightarrow{\mathcal{G}} \Delta R \xrightarrow{\mathcal{E}} s_i \xrightarrow{\mathcal{M}} \widetilde{O}_i, \tag{1.3}$$

where $\widetilde{\mathcal{W}}$ denotes the unresolved interactional world, $\mathcal{G}$ the generonic boundary, ΔR the physical alteration of the measuring system, $\mathcal{E}$ the encoding operation, s_i the finite symbol, and $\mathcal{M}$ the model through which the symbol becomes an observable $\widetilde{O}_i$. The diagram is not offered as a claim that these stages are always temporally discrete. It separates operations that are frequently compressed into the single word ‘measurement’.

The empirical record begins with ΔR, because without a physical alteration there is no retained difference and therefore no datum. The model may infer a prior event, entity or state, but that inference is not a second unmediated encounter with the source. It is a symbolic reconstruction constrained by the registered change. The measured world is consequently a world admitted through transformations, and those transformations form part of what has been measured.

Chapter 2

From One Registration to Plurality

A single registered step establishes that a distinction has occurred, but it does not yet establish a spatially or temporally articulated plurality. A first registration may be represented in the following form, with the understanding that the unity is a physically instantiated event rather than an extensionless numeral.

$$\widetilde{D}_1 : 0 \longrightarrow 1. \tag{2.1}$$

The symbol 1 in this expression does not denote an extensionless mathematical unity existing independently of a physical substrate. It denotes one admitted distinction, instantiated through an extended registering event. Before the system can speak of separation, displacement, direction, interval or structure, it must preserve at least two registrations as non-identical.

The first-order non-single-distinction event therefore has the following form, in which two registrations must remain separately admissible within the complete measurement arrangement.

$$\widetilde{D}_2 : \widetilde{r}_1 \neq \widetilde{r}_2. \tag{2.2}$$

This apparently simple inequality contains the beginning of measured geometry. The two registrations must not only occur; they must remain separable under the resolving capacity of the complete measurement system. Their distinguishability depends upon the source, apparatus, detector response, noise, integration interval, encoding convention and classification rule. The relevant threshold is consequently not a naked geometrical distance but a system-dependent condition that may be represented provisionally as

$$d(\widetilde{r}_1, \widetilde{r}_2) > \delta_{\text{system}}. \tag{2.3}$$

Here δ_{system} gathers the practical and conceptual conditions under which two registrations are admitted as distinct. If two responses overlap so extensively that the encoding procedure returns one basin, the symbolic system cannot obtain plurality merely by naming two hidden causes. A model may hypothesise two contributors, but measured separability has not thereby been established.

This distinction is especially important for quantum experiments, where finite distributions are frequently compressed into exact alternatives. A physical apparatus produces spots, bands, pulses or populations possessing spatial and temporal width. A later classifier assigns these outcomes to discrete symbols. The exactness belongs initially to the classification rule, while the physical registrations remain extended and uncertain. The resulting symbolic binary is useful, but its utility should not erase the finite distributions from which it was constructed.

Plurality is therefore a measurement achievement rather than an automatic consequence of writing more than one symbol. The mathematical expression $a + b$ contains two terms by construction. A physical claim that there are two independently existing constituents requires a measurement arrangement capable of sustaining their difference. Symbolic separability and measured separability are related only when the trajectory connecting them is preserved.

Chapter 3

Extent, Storage and the Finite State

Finite Symbolic Mechanics begins from the commitment that every physically instantiated symbol has extent. A detector event occupies a region, persists for an interval and alters a substrate. A written numeral, a magnetic state, a voltage difference and a stored bit all require a physical implementation. An extensionless point may be used within formal calculation, but it cannot serve as the complete description of a physical registration because an entity with no extent cannot be physically separated, retained or inspected.

The difference between a formal symbol and a measured symbol may be expressed through the following representation, which attaches physical and historical conditions to the admitted unity.

$$\widetilde{1} = (G, t, \delta, H, C), \tag{3.1}$$

where G records the geometry and extent of the registration, t its temporal placement or duration, δ its uncertainty, H its provenance, and C the consensus conditions under which it is admitted as one distinction. This notation is schematic rather than exhaustive. Its purpose is to prevent the symbolic value from being detached from the physical and historical conditions of its production.

The requirement of extent leads naturally to a minimum three-dimensional measured world. A physical mark may be represented on a nominal surface or along a nominal line, but the substrate, mark and detector remain extended. A two-dimensional image is produced by a three-dimensional device, retained in a three-dimensional medium and inspected through further extended interactions. The reduction to a plane is an operation performed within the symbolic model rather than an abolition of the physical extent of the symbol.

Finite Symbolic Dynamics begins when these finite states are related through change. A state may be represented in the following provenance-bearing form.

$$\widetilde{S}_i = (G_i, t_i, \delta_i, H_i, C_i), \tag{3.2}$$

An experimentally available transition can then be represented as a relation between two such states, without presuming that the transition has disclosed a hidden point-object.

$$\widetilde{S}_i \longrightarrow \widetilde{S}_{i+1}. \tag{3.3}$$

The measured world is then built from trajectories of finite, provenance-bearing registrations rather than from dimensionless points endowed in advance with ideal properties. The point, fraction, eigenvalue or particle may later be introduced as a compression of recurrent trajectories, but it does not occupy the foundational position.

Part II

From Registration to Semantic Agent

Chapter 4

Measurement as Selective Compression

An apparatus does not transfer the whole originating interaction into the scientific record. It produces a constrained physical response, and the encoding system retains selected features of that response. Even an instrument designed to be linear, calibrated and reproducible remains an interacting physical system with limited bandwidth, thresholds, response times and finite storage. Measurement is therefore both revelation and reduction: something becomes available, but it becomes available only through a restricted form.

The passage may be represented by the following trajectory, whose economy should not be mistaken for identity between its stages.

$$\widetilde{I} \longrightarrow \Delta R \longrightarrow s_i, \tag{4.1}$$

where $\widetilde{I}$ is the wider interaction, ΔR the instrument response and s_i the encoded symbol. Their non-identity is expressed explicitly in the following relation, which keeps the encoded product distinct from the wider event.

$$s_i \neq \widetilde{I}. \tag{4.2}$$

The inequality does not imply that the symbol is false. It indicates that the symbol is a finite product of the interaction rather than a complete reproduction of it. A detector pulse may preserve timing and intensity while discarding spatial detail. A diffraction pattern may preserve relational periodicities while requiring reconstruction before atomic coordinates are assigned. A thresholded event may preserve occurrence while discarding variations beneath the threshold.

Compression is indispensable to scientific practice. Without it there would be no stable datum, comparison or calculation. The difficulty appears when the compressed registration is treated as identical to the originating event and when the discarded apparatus trajectory disappears from the later explanation. The more efficient the scientific notation becomes, the easier it is to forget the physical operations that made the notation possible.

The analogue-to-digital converter provides a particularly clear instance of the generonic operation. A continuously varying electrical response is sampled, thresholded and mapped to finite values. The resulting sequence can be stored and processed, but its sample rate, bit depth, filtering, saturation behaviour and timing become part of the epistemic content of the data. A symbolic stream without these conditions is not a transparent copy of the input. It is a transformed trajectory whose admissibility depends upon the conversion architecture.

This point generalises beyond electronic converters. A photographic plate, scintillation counter, cloud chamber, CCD, crystallographic detector and human perceptual classification all perform some form of distinction and retention. The material implementation changes, but the structural problem remains. The world does not arrive in the paper as an already written sequence of scientific nouns. It is made symbolically available through apparatus-dependent changes.

Chapter 5

The Construction of the Observable

The word *observable* appears to promise proximity to direct experience, but within quantum mechanics it already belongs to an organised theoretical framework. An observable is associated with a defined measurement procedure and represented mathematically, commonly by an operator. Its value is not simply found waiting on the surface of the world. It is produced through a chain that joins physical interaction, instrument response, encoding, calibration and model.

The layers may be separated through the following trajectory, which displays the interpretive distance between the original interaction and the final observable.

$$\text{interaction} \longrightarrow \text{apparatus change} \longrightarrow \text{signal} \longrightarrow \text{datum} \longrightarrow \text{observable}. \tag{5.1}$$

Ordinary exposition often compresses the chain by saying that an observable was measured. Such language is convenient, but it allows the final model-defined quantity to appear as though it stood immediately before the instrument. A more provenance-preserving account would state that a physical registration was encoded and interpreted as the value of an observable under a specified model and calibration procedure.

The distinction is not verbal pedantry. When the model-defined observable is mistaken for the initial physical event, the inferential structure is hidden. Agreement between an observable and a calculation may then be treated as direct access to a proposed microscopic constituent. The apparatus becomes transparent in the narrative even when its physical organisation is indispensable to the result.

Within FSM, the observable belongs to the measured and consensus-stabilised world. It is constrained by physical interaction and cannot be chosen arbitrarily, but it is also conditioned by the communal rules determining what counts as a measurement, how the apparatus is calibrated, which transformations are accepted, and which uncertainties are retained. The observable is therefore neither a free invention nor an unmediated fragment of the pre-symbolic world. It is a finite symbolic achievement.

Chapter 6

The Emergence of the Semantic Agent

A scientific model must identify regularities, and naming a recurrent regularity is often an efficient and productive act. The problem addressed here is not the introduction of a name but the gradual movement of that name from descriptive compression to independent causal agent. A semantic agent may be provisionally defined as a named component constructed from registered regularities to which causal, explanatory or behavioural agency is subsequently assigned within scientific language.

The general trajectory has the following form, in which explanatory agency is progressively concentrated into a named component.

$$\begin{aligned}\{\text{registrations}\} &\longrightarrow \text{stable relation} \longrightarrow \text{parameter} \longrightarrow \text{name} \\ &\longrightarrow \text{property bearer} \longrightarrow \text{causal agent.}\end{aligned} \tag{6.1}$$

At the beginning of this trajectory there are interactions distributed across a source, specimen, environment and apparatus. At the end there is a compact sentence in which a single noun performs the action. The electron moves, the charge interacts, the spin couples and the field mediates. Grammar concentrates the agency that previously belonged to the complete interactional arrangement.

The resulting explanation can become recursively closed. Measurements support the construction of the electron, after which the electron is said to cause the measurements. This may provide a stable and economical predictive language, but the apparent independence of the agent is not a new observation. It is the consequence of a successful semantic compression whose provenance has receded from view.

The term *semantic agent* does not decide whether the name has a physical referent. It marks a stage in the explanatory process. An agent may refer to a durable feature of the world, a model-relative invariant, a useful fiction, or a mixture of these. The required investigation is not settled by assigning one of those labels in advance. It begins by recovering the measurements, encodings and added commitments through which the agent obtained its role.

Chapter 7

Greene, Pascal and the Continuation of Decomposition

Robert Greene's early eighteenth-century criticism of the division of the world into matter and vacuum provides a historical image for the present problem. If the world is represented as matter plus vacuum, each term may be divided again, and the repeated division produces an indefinitely branching symbolic account. The decomposition can become increasingly elaborate without recovering the undivided world from which it began.

The structure may be written in the following open-ended form, with the ellipsis marking the ability of symbolic division to continue under its own rules.

$$\widetilde{\text{world}} \longrightarrow \widetilde{\text{matter}} + \widetilde{\text{vacuum}} \longrightarrow \cdots . \tag{7.1}$$

The ellipsis is not empty. It marks the capacity of a symbolic system to continue differentiating its own terms. Once a distinction has been admitted, each side can become a new field of decomposition. The cost of ink continues, even when the instrument can no longer produce independently resolved marks corresponding to the newly named constituents.

Pascal's reflections on definition provide the complementary limit. Language cannot define every term through further terms without circularity or regress. Some distinctions are stabilised through use, shared practice, demonstration or prior acceptance. The symbolic system therefore depends upon a boundary that it cannot wholly reconstruct from within its own definitions.

The Greene–Pascal conjunction identifies a general problem. Greene supplies the indefinite divisibility of the represented world, while Pascal supplies the inability of language to ground every division through additional language. Together they show how symbolic resolution may continue after physical resolution has failed. The model acquires more terms, but the measurement system does not necessarily acquire more independently distinguishable events.

The term *Greene–Pascal semantic split* describes the act by which a relational registration is divided into separately named explanatory components. The split may prove computationally effective, but its effectiveness does not establish that each term was independently encountered. The history of the split must remain visible if the symbolic decomposition is not to be mistaken for a direct inventory of the world.

Part III

Charge, Mass and the Point-Agent

Chapter 8

The Charge–Mass Separation

The charge–mass distinction is foundational to the conventional construction of the electron. Experiments do not begin by presenting a separate substance called charge and another called mass. They register responses within prepared arrangements involving fields, accelerations, trajectories, timings, collisions and detectors. The mathematical model organises these responses through quantities denoted by q, m and, in some arrangements, the ratio q/m.

The presence of the ratio does not mean that two independently observed objects have been joined. It means that the response has been represented using two parameters whose relation is experimentally constrained. Later measurement systems may stabilise separate numerical values, but each stabilisation remains dependent upon a network of models, standards and calibrations. The question is therefore not whether the symbols can be manipulated separately. It is what measurement licenses the physical separability attributed to them.

Within FSM, the critical inequality is therefore expressed as follows, because the independent manipulation of symbols cannot by itself warrant the physical independence of their proposed referents.

$$\text{symbolic separability} \not\Rightarrow \text{measured physical separability.} \tag{8.1}$$

The symbols q and m can occupy independent positions in an equation because the formal language permits their separation. A physical claim that charge and mass are independently existing properties requires a corresponding distinction within measurement. If every registration involves their chained response, their ontological separation remains an interpretation of the model rather than an independently presented fact.

This does not require the immediate assertion that charge and mass are identical. It requires suspension of an inherited semantic division until its measurement provenance has been reconstructed. A charge–mass description may eventually stabilise as a better representation of the interaction, or the conventional separation may survive under more carefully stated operational conditions. The purpose of the audit is to expose the commitments rather than to predetermine the result.

The electron emerges within this history as a persistent bearer to which charge, mass and later spin are attached. Each property performs explanatory work, and their conjunction creates the familiar particle-agent. Yet the completed noun conceals the sequence of experiments, calculations and consensus decisions through which the properties were separated and assembled. The electron appears at the end of the inferential chain and is then placed at its beginning as the cause of the registrations.

Chapter 9

Point-Likeness and the Removal of Extent

The phrase 'point particle' contains a movement from an experimental limitation to an ontological image. Experiments may fail to resolve internal structure below an available scale. The justified measurement statement is that no internal structure was distinguished under specified conditions and within a stated uncertainty. The stronger model statement is that the represented entity has no extent.

The transition may be displayed in the following form, which makes visible the movement from an indexed experimental limitation to an unindexed model commitment.

$$\text{no resolved internal structure} \longrightarrow \text{extensionless point-agent.} \tag{9.1}$$

These statements are not equivalent. The left side is indexed to an instrument, energy range, model and resolution criterion. The right side removes that indexing and assigns zero extent to the object itself. The mathematical point may be a valuable idealisation, but the success of the calculation does not physically instantiate an object with no dimensions.

Every experimental indication attributed to an electron is extended. A track has width and length, a detector event occupies a region and duration, a scattering distribution covers angles, and a spectral line possesses finite width. The inferred agent may be treated as point-like within a model, but the measurement record contains no extensionless mark. An extensionless mark could not itself be stored, separated or read.

The point-agent is therefore a powerful compression. It allows interactions to be calculated without representing the full geometry of the registering system. The compression becomes problematic only when its omitted extent is forgotten and the ideal point is said to have been observed. FSM retains the formal point as a permitted instrument within a symbolic calculus while refusing to identify it with a physically instantiated primitive.

Part IV

Stern–Gerlach as a Provenance Study

Chapter 10

The Complete Experimental Interaction

The Stern–Gerlach experiment is especially valuable because the passage from physical registration to semantic agent can be reconstructed with unusual clarity. The original experiment used a beam of neutral silver atoms passing through an inhomogeneous magnetic field. The resulting deposition pattern exhibited a separation that could be organised as two outcome regions. What the apparatus registered was an extended spatial distribution created by the complete arrangement.

The primary experimental trajectory is better represented by the following extended relation, in which no single component of the arrangement is allowed to inherit the agency of the whole prematurely.

$$\begin{aligned}&\text{source} + \text{prepared silver beam} + \text{collimation} + \text{field geometry}\\&\qquad + \text{flight interval} + \text{detector} \longrightarrow \text{finite deposition distribution.}\end{aligned} \tag{10.1}$$

No single term on the left is dispensable from the actual event. The beam preparation determines which atoms enter the arrangement, the collimation constrains the geometry, the field gradient shapes the response, the transit interval permits separation, and the detector converts arrival into a stable mark. The experimental result belongs first to this entire interactional system.

The later phrase 'the spin of the electron was observed' is therefore a profound compression. It removes the silver atom, most of the apparatus and the inferential chain by which the registered pattern is associated with an angular-momentum component and then with electron spin. The compact sentence may be suitable within a community that already shares the model, but it should not be mistaken for a provenance-complete account.

At the level of first distinction, the experiment records a physical distribution. At the level of non-single distinction, the arrangement supports the classification of that distribution into two outcome basins. The two-valued result belongs initially to the apparatus-mediated registration. The attribution of the result to an intrinsic property requires further theoretical steps.

Chapter 11

From Finite Distributions to a Binary Symbol

The physical traces in a Stern–Gerlach arrangement are not dimensionless values. They possess finite width, intensity variation and possible overlap. A classification operation converts these extended registrations into a binary alphabet:

$$\text{finite spatial distributions} \xrightarrow{\mathcal{C}} \{+, -\}. \tag{11.1}$$

The exactness of the binary belongs to the symbolic output of $\mathcal{C}$. The physical distributions remain extended. The classification may be highly stable, but its stability does not retroactively make each originating event an ideal sign without width, uncertainty or history.

The encoding necessarily removes information. It may discard the continuous position within each basin, the variation in intensity, the spatial width of the beam, marginal events, detector nonuniformity, temporal spread and aspects of the magnetic field. Such removal is not evidence of experimental failure. It is the operation that makes a binary result available. The scientific obligation is to retain knowledge that the binary was produced by compression.

Once the physical distributions have been replaced by $+$ and $-$, the symbolic system permits exact combinatorial and algebraic operations. The binary outcomes can be counted, correlated and represented by ideal mathematical states. This creates a powerful calculational framework, but the finitude of the registration should remain attached to the exactness of the symbol. Otherwise, the symbolic distinction is projected backwards into the world as though it had been found there in the same form.

The Stern–Gerlach result is therefore not diminished when described as a first-order non-single-distinction event. On the contrary, the description identifies the genuine achievement of the experiment. The apparatus sustains two reproducible response basins where a classical continuous distribution might have been expected under the inherited model. What remains open is the ontology used to explain that distinction.

Chapter 12

The Construction of Spin-$\frac{1}{2}$

The inferential movement from the detector distribution to spin-$\frac{1}{2}$ contains several stages that ordinary language frequently collapses. A simplified trajectory is given below so that the added semantic commitments can be recovered.

$$\begin{aligned} \text{two outcome regions} &\longrightarrow \text{two-valued magnetic response} \\ &\longrightarrow \text{angular-momentum component} \\ &\longrightarrow \text{electron spin} \longrightarrow \text{spin-}\tfrac{1}{2}\text{ particle.} \end{aligned} \tag{12.1}$$

The spin quantum number and the component values should also remain distinct. In the conventional formalism, their relation is represented as follows, although the detector itself does not display either expression as a literal fractional mark.

$$s = \frac{1}{2}, \qquad S_z = \pm\frac{\hbar}{2}. \tag{12.2}$$

The detector does not display a dimensionless half. It records an extended spatial or electrical difference. The fraction enters through a mathematical structure involving the angular-momentum algebra, the chosen measurement direction and Planck's reduced constant. The exact fractional value is a relation within the model rather than an isolated fraction physically deposited upon the detector.

The movement from two basins to an intrinsic spin property adds commitments. It introduces persistent particle identity, possession of an internal property, exact fractionality, an idealised measurement axis and a degree of separability between spin and the remaining interaction. These commitments may support a successful predictive structure, but they are not identical to the initial registration.

The familiar words 'spin up' and 'spin down' further stabilise a spatial image. The language encourages the reader to imagine a small object possessing one of two orientations, even though quantum theory itself warns that spin is not ordinary classical rotation. The semantic agent therefore carries both formal sophistication and residual pictorial agency. It is said to orient, flip, couple and precess, and each verb strengthens its apparent independence.

An FSM analysis need not replace the spin formalism before it can identify this trajectory.

It can retain the calculated relations while marking which part of the account belongs to physical registration, which to encoding, which to formal representation and which to ontological interpretation. The result is not a dissolution of spin but a recovery of its provenance.

Chapter 13

The Transfer of Agency

At the beginning of the Stern–Gerlach trajectory, explanatory agency is distributed across the complete interaction. The source, atom, field, geometry, flight interval and detector jointly produce the registration. The model then concentrates this agency into a selected object, after which a property of that object is allowed to explain the result.

The movement may be represented by the following trajectory, which shows the progressive concentration of apparatus-wide agency into an inferred property.

$$\text{apparatus–}\widetilde{\text{system}}\text{ interaction} \longrightarrow \widetilde{\text{particle}} \longrightarrow \widetilde{\text{spin}} \longrightarrow \widetilde{\text{outcome}}. \tag{13.1}$$

The final expression is shorter and easier to use than the full experimental history. Its compression is precisely what gives it explanatory force. Yet the property-agent did not enter through a separate detector channel. It was constructed as a means of organising the apparatus-wide relation and then placed behind the relation as its cause.

This transfer is not unique to quantum physics. Scientific language routinely moves from repeated relations to named objects and then uses the objects to explain the relations. Quantum mechanics makes the process especially visible because the inferred agents are separated from direct inspection by severe measurement limits, while the mathematical representation is exceptionally developed.

The issue is therefore not whether a directed explanatory trajectory exists. It plainly does. The issue is where direction and agency are located. An apparatus-wide interaction is progressively rewritten as the behaviour of an internal agent. The noun inherits the causal force of the larger trajectory while the history of that inheritance disappears.

Part V

Metrology and the Limit of Distinction

Chapter 14

Resolution, Precision and Accuracy

Discussions of small-scale measurement frequently collapse resolution, precision and accuracy into a single claim of seeing more deeply. These terms must be separated if the Greene–Pascal boundary is to be identified. Spatial resolution concerns the minimum separation at which two features can be distinguished. Positional precision concerns the repeatability or estimated uncertainty with which the location of a fitted feature can be assigned. Accuracy concerns agreement with an independently warranted reference.

An instrument may resolve a feature whose width is tens of picometres while a model fitted across many registrations estimates its centre with a precision of a few picometres. The resulting numerical precision does not mean that a distinct object a few picometres in size has been directly imaged. The parameter uncertainty may satisfy

$$\delta_{\text{parameter}} < \delta_{\text{instrument}}, \tag{14.1}$$

without implying that the independently resolvable distinction has acquired the same scale. The invalid identification would be

$$\delta_{\text{distinction}} = \delta_{\text{parameter}}. \tag{14.2}$$

Repeated measurements can narrow the uncertainty of a mean or fitted coordinate without creating a finer physical mark. The symbolic stream gains digits, while the physical resolving event may remain unchanged. The additional digits are not meaningless, but their meaning is conditional upon the repeated arrangement, statistical structure and reconstruction model.

Current high-resolution crystallographic and electron-microscopic methods enter the tens-of-picometres regime under favourable conditions, while some fitted positions are reported with still smaller precision. These achievements require complex sources, preparation procedures, controlled environments, detectors, computational reconstructions and interpretive models. They should therefore be described as extended measurement systems capable of sustaining particular distinctions, not as transparent eyes looking directly at independent microscopic agents.

The first-order non-single-distinction limit should consequently be stated cautiously. A working scale of approximately 10–20 pm may identify an important region in which current claims of position and separation become highly model-assisted, but it should not be treated as a single universal resolution constant. Different instruments, specimens and inferential tasks produce different boundaries. The value is a research marker around which the measurement provenance must be examined.

Chapter 15

Crystallography and Reconstructed Position

X-ray crystallography illustrates the distinction between registration and reconstruction. The detector records a diffraction pattern produced by interactions among radiation, crystal and apparatus. The atomic structure is not captured as a direct miniature image. It is reconstructed through scattering theory, intensity measurement, phase-related procedures, electron-density modelling and refinement.

The trajectory may be written in the following form, with each arrow standing for a material, mathematical or interpretive transformation that must remain available to provenance.

$$\begin{aligned} \text{crystal interaction} &\longrightarrow \text{diffraction intensities} \longrightarrow \text{encoded pattern} \\ &\longrightarrow \text{reconstructed density} \longrightarrow \text{atomic coordinates.} \end{aligned} \tag{15.1}$$

The final coordinate is a model-conditioned result. Its uncertainty may be small, particularly when numerous observations constrain a stable crystalline arrangement, but its precision cannot be identified directly with spatial resolution. A fitted centre can be determined more precisely than the system can separate two neighbouring features, just as the centre of a broad macroscopic distribution can be estimated more precisely than the width of any individual event.

The dependence upon an electron-density model is especially important. Different models can return different structural and thermal parameters from the same or similar diffraction data. This does not make crystallography arbitrary. It shows that the transformation from pattern to position includes theoretical commitments. The reconstruction gains its authority from the joint stability of apparatus, mathematical method, comparison and repeatability.

Within FSM, reconstruction remains a legitimate scientific instrument so long as it retains its provenance. The difficulty begins when a reconstructed coordinate is described as though the detector had directly marked an isolated object at the quoted scale. The reported position then acquires an immediacy that belongs to neither the instrument nor the physical registration.

Chapter 16

The Rhetoric of "Astonishing Accuracy"

The phrase 'astonishing accuracy' appears frequently in accounts of quantum theory. It is not a measurement result. It is an evaluation added to a result, and it carries a semantic effect. By presenting agreement as astonishing, the phrase encourages the explanatory framework to close around the successful calculation before its measurement and inferential premises have been unfolded.

The phrase commonly compresses several different claims. A calculated number may agree with an experimentally constructed value; a series of registrations may be highly repeatable; a fitted parameter may possess narrow reported uncertainty; and the formalism may predict a distribution across repeated trials. None of these claims is identical to direct spatial inspection of the semantic agents used in the calculation.

The rhetorical trajectory often takes the following form, in which evaluative language permits numerical agreement to carry an additional ontological confidence.

$$\text{numerical agreement} \xrightarrow{\text{evaluative language}} \text{ontological confidence.} \tag{16.1}$$

The prestige of the numerical match migrates towards the electron, field, state or virtual process through which the calculation is narrated. Agreement between two symbolic procedures is thereby allowed to support a much stronger conclusion about the direct descriptive status of the internal model.

A disciplined replacement would state that a theoretical calculation and an experimentally constructed quantity agree within a specified uncertainty under stated modelling, calibration and consensus conditions. This wording preserves the scientific content without adding a verbal instruction to admire it. The measured values, uncertainty and independence of the comparison should carry the argument.

The recurrence of 'astonishing accuracy' in large language model output is itself informative. The phrase occupies a stable basin within scientific exposition. A model trained across that exposition reproduces not only the factual relations but the inherited rhetoric through which a scientific community signals confidence. The adjective therefore functions as a semantic agent of a different kind: it acts upon the reader's trajectory by discouraging renewed inspection of the measurement chain.

The criticism does not require denying close numerical correspondence. It requires preventing correspondence from carrying claims it has not measured. A compact FSM statement would be

$$|\widetilde{x}_{\text{calculated}} - \widetilde{x}_{\text{measured}}| \leq \widetilde{\delta}, \tag{16.2}$$

where each term retains its provenance. The scientific result lies in the relation, not in an adjective placed around it.

Part VI

The Greene–Pascal and Alphonic Limits

Chapter 17

A Provisional Greene–Pascal Limit

The analysis now permits a provisional definition. The Greene–Pascal Limit is the boundary beyond which continued symbolic decomposition no longer corresponds to independently sustained physical distinctions and depends increasingly upon model-mediated reconstruction and semantic separation. It is the region in which the formal framework continues to produce smaller or more refined agents while the apparatus does not provide correspondingly independent marks.

The limit should initially be treated as a function rather than as a universal numerical constant. The following representation keeps its dependence upon the full measurement and interpretive system visible.

$$G_P = G_P(I, M, E, C, H), \tag{17.1}$$

where I represents the instrument, M the model, E the encoding process, C the consensus conditions and H the measurement history. A change in any of these may alter the finest distinction the complete system can sustain.

This dependence does not reduce the limit to subjective opinion. Instruments impose physical constraints, and repeated interactions may strongly stabilise a result. Consensus does not create the source interaction, but it determines the rules by which signals are classified, uncertainties accepted and reconstructions admitted as measurements. The Greene–Pascal Limit belongs to the coupled instrument–symbol system rather than exclusively to either side.

The limit can also be described as the boundary between further physical distinction and further semantic decomposition. On one side, a revised apparatus produces newly separable registrations. On the other, the same or similar registrations are decomposed through additional theoretical terms. The symbolic account becomes finer without an equivalent refinement in independently resolved events.

Quantum physics supplies many possible examples because its inferred agents are often several transformations removed from detector registrations. Charge, mass, spin, state and field may remain indispensable model coordinates, but their mutual separability should not be assumed merely because each has a separate name and symbol. At the Greene–Pascal Limit, the ink continues even when the separately measured marks do not.

Chapter 18

The Alphonic Limit

The Alphonic Limit concerns a more foundational boundary. It may be defined provisionally as the minimum finite physical extent at which a distinction can be instantiated, preserved and admitted into a symbolic system. Unlike the Greene–Pascal Limit, it is not simply the current frontier of an instrument. It concerns the proposed lower condition of physically realisable distinction itself.

The Alphonic Limit is therefore inseparable from extent. A distinction must occupy a physical configuration capable of differing from another configuration. It must persist long enough to participate in an interaction and be retained within a history. A purely extensionless or durationless event cannot function as a stored symbol because it supplies no physical basis for separation.

The relation between the two limits can presently be written as the following inequality, which leaves open the possibility that the empirical boundary lies above the foundational one.

$$\alpha \leq G_P(I, M, E, C, H), \tag{18.1}$$

where α denotes the Alphonic Limit. An improved instrument may reduce its Greene–Pascal Limit by sustaining finer distinctions, but this does not demonstrate that the Alphonic Limit has moved. The instrumental boundary may approach the foundational boundary without identifying it.

The Alphonic Limit should not be mistaken for the smallest number a theory can write. Mathematical notation can generate arbitrarily small symbolic magnitudes under its adopted rules. The proposed limit concerns the physical instantiation of difference, not the grammatical divisibility of a numeral. A symbolic fraction can continue long after the corresponding physical distinctions can no longer be separately produced or stored.

Chapter 19

One Boundary or Two

The relation between the Greene–Pascal and Alphonic limits should remain open. Their premature identification would repeat the very compression that the framework is designed to examine. The fact that both concern failed distinction does not prove that they name the same boundary.

If the limits are distinct, the Greene–Pascal Limit describes an instrument- and model-dependent frontier above the Alphonic Limit. This possibility is represented by the following inequality.

$$G_P > \alpha. \tag{19.1}$$

If they are asymptotically related, successive instruments and models may move G_P towards α without permitting equality to be demonstrated. The relationship would then take the following limiting form.

$$G_P \longrightarrow \alpha. \tag{19.2}$$

If they are eventually found to be two approaches to one boundary, their identity might be expressed through the following equivalence. Such an equivalence would require independent conceptual and empirical support rather than merely similar terminology.

$$G_P \equiv \alpha. \tag{19.3}$$

Each possibility carries a different research consequence. Distinct limits would preserve a region between the finest currently admissible reconstruction and the minimum possible symbol. Asymptotic relation would make the boundary approachable but not finally demonstrable. Identity would imply that the failure of measured decomposition and the failure of physical symbolic instantiation are one event viewed from opposite directions.

The available framework does not yet select among these possibilities. The decision requires more than linguistic symmetry. It requires careful analysis of spatial and temporal distinction, instrument dependence, storage, reconstruction and the conditions under which a result ceases to be a physical plurality and becomes only a symbolic one.

Part VII

Finite Symbolic Dynamics as a Reconstruction

Chapter 20

From Hidden Objects to Registered Trajectories

Finite Symbolic Dynamics offers an alternative order of construction. Instead of beginning with hidden point-objects that possess exact properties, it begins with finite states and admissible transitions. The central empirical object is a trajectory of registrations:

$$\widetilde{\Gamma} = \left(\widetilde{S}_0, \widetilde{S}_1, \ldots, \widetilde{S}_n\right). \tag{20.1}$$

Each state retains geometry, time, uncertainty, provenance and consensus conditions. A recurrent trajectory class may then be identified across controlled experiments. The model searches first for stable relational invariants rather than assigning an ideal object in advance.

The order becomes the following provenance-preserving trajectory, in which naming occurs only after stable relational structure has been identified.

$$\text{finite trajectories} \longrightarrow \text{stable relational invariants} \longrightarrow \text{optional semantic agent.} \tag{20.2}$$

The word *optional* is important. A named entity may provide useful compression and permit efficient prediction. FSD does not prohibit the name. It requires the name to remain attached to the trajectory class from which it was constructed and prevents the compression from silently replacing its provenance.

This approach also changes the meaning of law. A law need not initially describe what an invisible agent does. It may describe the stable transformations between classes of finite registered states under specified arrangements. Agency can remain distributed across the interaction unless measurements justify a more local attribution.

The resulting framework is less narratively compact than particle-centred language, but it makes fewer unmarked commitments. The cost of the additional description is repaid through clarity concerning what was registered, what was reconstructed and what was inferred.

Chapter 21

A Provenance Record for Semantic Agents

If semantic agents remain useful, they can be represented with an explicit provenance record. A provisional form is given below, with each component retaining a different part of the agent's construction history.

$$\widetilde{A} = (N, R, E, M, K, U), \tag{21.1}$$

where N is the agent's name, R the class of supporting registrations, E the encoding trajectory, M the mathematical model, K the added commitments and U the unresolved alternatives and uncertainties. Such a record would prevent the name from becoming detached from the measurements that gave it meaning.

An electron represented in this way would not be merely a lexical item referring to an assumed microscopic object. It would be a compact index to a family of scattering patterns, tracks, detector pulses, spectral relations and other registered trajectories, together with the models that unify them. The question of physical reference would remain open to further measurement rather than being settled by grammatical familiarity.

The record would also expose where different experimental traditions support different aspects of the same agent. Charge, inertial response, magnetic response and spectral behaviour need not originate in one transparent observation. Their unification under a single noun is a historical and theoretical achievement. Provenance shows the joints in that achievement.

The approach permits semantic agents to be compared by their operational distance and provenance distance. Operational distance concerns the disagreement between predicted and registered trajectories. Provenance distance concerns the number and character of transformations between registration and the final agent. A model may have small operational distance while the agent has large provenance distance. Close prediction and direct observation are therefore not equivalent.

Chapter 22

The Agency-and-Provenance Audit

The preceding analysis can be turned into a systematic research method. For each quantum concept, the audit begins with the physical alteration of the apparatus and follows every transformation leading to the final explanatory sentence. It records how the signal was encoded, how the observable was defined, where the mathematical parameter entered, when a noun was introduced, which properties were attached to it and when the noun became the subject of a causal verb.

The audit must also identify what disappeared. Apparatus geometry, response functions, thresholds, rejected events, reconstruction assumptions, calibration history and classification rules frequently vanish from the compressed account. Their removal may be necessary for everyday calculation, but it should remain recoverable whenever ontological conclusions are drawn.

The method is especially suited to electrons, photons, wavefunctions, collapse, entanglement, virtual particles, quantum fields and vacuum states. Each requires its own history. It would be a mistake to declare all such agents unreal in one gesture, because they do not have identical measurement trajectories. The purpose is discriminating reconstruction rather than collective dismissal.

For each case, the decisive questions concern the registered distinction, the encoding process, the inferred regularity, the introduction of the semantic agent, the transfer of causal agency and the point at which separately measured distinctions give way to symbolic decomposition. The audit thereby locates the Greene–Pascal Limit within a specific scientific practice instead of treating it only as an abstract philosophical boundary.

Part VIII

Consequences and Future Direction

Chapter 23

Prediction without Ontological Promotion

A theory may produce stable numerical correspondences without every internal term being independently observed. The formal trajectory and the registered trajectory may agree within uncertainty, as represented by the following relation.

$$\widetilde{P} \leftrightarrow \widetilde{R}. \tag{23.1}$$

This correspondence is scientifically important. It shows that the model preserves relations capable of anticipating or organising registrations. It does not, by itself, establish

$$\text{formal semantic agent} = \text{independently observed physical constituent}. \tag{23.2}$$

The distinction allows the predictive structure of quantum mechanics to be studied without automatically importing its ordinary ontology. It also permits alternative descriptions to be compared at the level of registered trajectories. If two models organise the same results using different semantic agents, numerical success alone cannot decide which population of agents constitutes the unresolved world.

The refusal of automatic ontological promotion is not a refusal of physical reality. It is an insistence that claims about physical constituents remain indexed to the measurement pathways that support them. A semantic agent may later acquire stronger status if new instruments provide independently sustained distinctions corresponding to its proposed structure.

This position avoids the false choice between complete realism and complete instrumentalism. FSD can treat the model as a physically constrained symbolic construction whose components possess differing degrees of provenance, independence and measurement support. Reality is not reduced to language, but language is no longer permitted to conceal its role in constructing the measured world.

Chapter 24

The Measured World as Consensus-Stabilised World

Scientific communities stabilise instruments, calibration procedures, encoding conventions, mathematical representations and admissibility criteria. The resulting measured world is not arbitrary because it remains constrained by reproducible interaction. Yet it is not an unmediated copy of a world standing outside all measurement. It is a consensus-stabilised symbolic world produced through the generonic boundary.

A schematic expression is given below, not as a known algebraic identity but as a reminder that the scientific world depends upon more than the unresolved source alone.

$$\widetilde{\mathcal{W}}_{\text{science}} = F(\widetilde{\mathcal{W}}, I, E, M, C, H), \tag{24.1}$$

where the scientific world depends upon the unresolved interactional world together with instrument, encoding, model, consensus and history. The function F should not be read as a known algebraic operation. It marks the dependence that ordinary scientific language often removes.

Consensus in this framework does not mean that any claim becomes true if enough people accept it. Consensus establishes operational admissibility: which detector response counts as an event, which calibration chain is trusted, which transformation is reproducible, which uncertainty is acceptable and which semantic agent is permitted to organise the results. Physical resistance remains present because the apparatus may fail to produce the expected distinction regardless of expectation.

The observable world is therefore neither purely discovered nor freely invented. It is constructed under constraint. Its stability arises from the repeated coupling of physical interactions, instruments and symbolic communities. The stronger and more reproducible that coupling becomes, the easier it is to forget that a construction occurred.

Chapter 25

Towards a Renaming of Quantum Mechanics

The inherited name *quantum mechanics* already carries historical commitments. It suggests quanta as foundational entities and mechanics as the governing form of explanation. The present framework begins elsewhere, with finite registration, distinction, extent, uncertainty, provenance and trajectory. A future name may therefore be required if the reconstructed field develops sufficiently far from the original semantic basin.

The replacement should not be chosen prematurely. A name can constrain a research programme by deciding in advance what its primitive objects are. The emerging terminology should avoid presuming particles as foundational, avoid identifying stepwise registration with stepwise ontology, preserve the physical extent of symbols, distinguish observation from reconstruction, and make the transfer of semantic agency visible.

Finite Symbolic Dynamics presently offers a broad home for this work because it describes change among finite symbolic states without committing the unresolved world to the same organisation. A more specialised term may later emerge for the reconstructed domain conventionally occupied by quantum mechanics. That term should be allowed to stabilise through repeated use and empirical development rather than being imposed before the conceptual distinctions are secure.

Chapter 26

Conclusion: Recovering the Cost of the Agent

The complete trajectory developed in this monograph can be gathered into the following sequence. Its extended form is retained because the conclusion depends upon refusing to compress the intermediate transformations.

$$\begin{aligned} \text{interaction} &\longrightarrow \text{physical change} \longrightarrow \text{registered distinction} \\ &\longrightarrow \text{encoded symbol} \longrightarrow \text{model-defined observable} \\ &\longrightarrow \text{inferred property} \longrightarrow \text{semantic agent} \longrightarrow \text{agent explains interaction.} \end{aligned} \tag{26.1}$$

The familiar quantum world appears near the end of this sequence rather than at its beginning. The electron, charge, mass and spin are not presented together by the first detector event. They are stabilised through multiple experimental and mathematical trajectories, assembled into a model, and granted explanatory agency through scientific language. The completed model may efficiently organise registrations while remaining several inferential transformations removed from them.

The central criticism is not that quantum physics merely invents a fictional world. Such a statement would erase the physical resistance, repeatability and mathematical discipline that constrain the model. The criticism is that the semantic agents of the model are frequently detached from their measurement provenance. Once detached, they appear as independently observed constituents and are permitted to cause the registrations from which they were originally inferred.

The Stern–Gerlach experiment displays this transformation with particular clarity. A complete interactional arrangement produces finite spatial distributions. A classification rule converts those distributions into a binary distinction. A mathematical framework represents the distinction through angular-momentum relations, and a semantic agent called spin-$\frac{1}{2}$ becomes an intrinsic possession of an electron. Each stage may be defensible within its domain, but the stages are not identical. Their compression creates an appearance of direct observation that the apparatus itself does not supply.

The metrological analysis reinforces the same conclusion. Resolution, positional precision and accuracy are different quantities. A reconstructed coordinate may be reported with picometre precision without the instrument having directly resolved an independent picometre-sized object. Repetition and model fitting can add symbolic digits without producing an equivalent series of finer physical marks. The statement of success must therefore retain the measurement and reconstruction conditions under which the numerical agreement was produced.

The Greene–Pascal Limit names the region in which further semantic decomposition ceases to correspond to independently sustained measurement distinctions. The Alphonic Limit names the proposed minimum physical-symbolic distinction itself. They may eventually prove distinct, asymptotically related or identical. Their relationship remains open because the framework should not compress two emerging concepts before their separate trajectories have been investigated.

The cost of a quantum agent is not merely the ink required to write its name. It is the discarded history of apparatus, interaction, threshold, calibration, reconstruction, consensus and uncertainty that allowed the name to stabilise. Once that history is removed, the agent appears to stand alone and to explain the registrations from which it was derived. Finite Symbolic Mechanics does not begin by abolishing the agent. It returns the agent to its provenance.

At the Greene–Pascal Limit, symbolic decomposition continues while separately measured distinction begins to fail. At the Alphonic Limit, distinction itself reaches its proposed physical boundary. A symbolically divisible world is not thereby an indefinitely measurable world, and no semantic agent should be allowed to conceal the point at which measurement gave way to inference. The future task is not to stop inference, for science cannot proceed without it, but to ensure that every inference continues to carry the trajectory of its construction.

Notes on Terminology

The term *generonic boundary* denotes the interactional boundary at which an unresolved physical process produces a finite, retainable distinction capable of entering a symbolic system. The term does not assert that the source process is discrete. It identifies the production of empirical and symbolic availability.

The term *semantic agent* denotes a named model component constructed from registered regularities and subsequently granted causal, explanatory or behavioural agency within scientific language. The term does not decide whether the agent has a physical referent. It preserves the question of how that referent is warranted.

The term *first-order non-single-distinction event* denotes the minimum measurement situation in which at least two registrations remain separately admissible rather than collapsing into one response basin. It is a condition for measured plurality and should not be confused with the precision of a fitted parameter.

The term *Greene–Pascal Limit* denotes the provisional boundary beyond which continued symbolic decomposition no longer corresponds to independently sustained physical distinctions and depends increasingly upon model-mediated reconstruction and semantic separation. The limit is presently treated as dependent upon instrument, model, encoding, consensus and provenance.

The term *Alphonic Limit* denotes the proposed minimum finite physical extent at which a distinction can be instantiated, preserved and admitted into a symbolic system. Its relation to the Greene–Pascal Limit remains a subject for further work.

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