Models, Measurement, and the Language That Holds Them

Reflections on Finite Representation, Endogenous Instruments, and the Possibility of Engineered Epochal Shifts

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Abstract

This pair of linked reflections develops a framework for understanding scientific models as finite symbolic constructions shaped by both exogenous measurement and endogenous symbolic operations. Chapter 1 sets out the core distinctions between types of prediction, the double boundary of scientific epochs, finite representation effects, the noun as a stabilised process, and symbolic drag. It proposes a practical research protocol that treats language itself as an object of disciplined measurement. Chapter 2 applies this framework to the dynamics of scientific change. It contrasts the largely passive accumulation of anomalies described by Kuhn with an active programme of deliberately searching for and working with incommensurability, made newly feasible by large language models as powerful endogenous instruments. Together the chapters suggest that explicit attention to the symbolic layer, supported by new instruments capable of traversing it at scale, may render epochal transitions more legible and, to a limited but non-trivial degree, more open to constructive engagement.

Chapter 1: Models, Measurement, and the Language That Holds Them

A model is always a model. It may be the best available in an epoch, but movement into another epoch requires both improved exogenous measurement and careful examination of the endogenous measurements made within language.

Purpose. This chapter records a line of reasoning developed through reflection on earlier Finite Mechanics work and its later extension into Finite Symbolic Mechanics and Geofinitism. It is intended as a working foundation rather than a final claim.

1. Orientation: a model remains a model

The central clarification is modest in wording but radical in consequence: a model is always a model. It may be the best available model in a given epoch. It may organise a vast range of measurements with extraordinary accuracy. It may be indispensable for engineering and prediction. None of these achievements converts it into the world itself.

This is not an argument against modelling. It is an argument for keeping the model visible. When a model succeeds for long enough, its categories can become grammatically and institutionally stabilised. Terms such as mass, electron, energy, field, particle, space, time, constant, and law begin to sound like direct inventory terms for nature. The historical measurements, instruments, transformations, conventions, and exclusions that produced those terms recede from view. The noun becomes slow enough to appear foundational.

The danger is not that the model is false in a simple sense. The danger is that its success hides its conditions of formation. A mature model may be the best compression of the measurements an epoch can make while still excluding distinctions that its instruments and language cannot yet hold.

The question is therefore not merely whether a model works. The question is what measurements, symbols, bases, histories, and admissibility rules make its working possible.

This formulation also changes the meaning of scientific replacement. A later model does not necessarily reveal the thing that the earlier model failed to name. It may reorganise the same measurements under a different symbolic grammar. It may open new measurements. It may preserve much of the earlier model as a local approximation. It may also disclose that some apparently physical object was partly the residual of a compressed representation.

2. Scientific epochs and the double boundary of measurement

An epoch of inquiry is bounded in at least two ways. It is bounded by what can be measured exogenously, through instruments and interactions with what lies beyond the current symbolic system. It is also bounded by what can be measured endogenously, within the available language, mathematics, categories, and rules of admissibility.

The first boundary is familiar. New telescopes, detectors, microscopes, clocks, interferometers, imaging systems, and computational devices create distinctions that were previously unavailable. They do not simply add more facts to an unchanged language. They can destabilise old categories by showing that apparently singular objects contain unresolved structure.

The second boundary is less often treated as a measurement boundary. Yet language repeatedly measures itself. A definition is made using other symbols. A proof transforms accepted symbolic relations. A theory is compared with another theory inside a historically inherited vocabulary. A constant is identified through a network of equations and calibration procedures. These are endogenous operations. They can reveal structure, but they cannot automatically escape the assumptions carried by the language in which they operate.

Epoch $E = \{\text{available exogenous distinctions}, \text{available endogenous distinctions}\}$

To move into another epoch, both boundaries may need to change. Better instruments without better language can produce new observations that are forced into old nouns. New language without new exogenous measurement can become an elegant rearrangement of the existing symbolic basin. A substantial transition requires both a new distinction and a symbolic capacity capable of holding it.

New epoch $\approx$ improved exogenous measurement + revised endogenous measurement

The approximation sign is deliberate. No transition is instantaneous or complete. New instruments are interpreted through old concepts, while new concepts often precede the measurements that could stabilise them. Epochs overlap. Their models coexist, compete, and borrow from one another.

3. Exogenous and endogenous measurement

3.1 Exogenous measurement

Exogenous measurement is interaction that produces a distinction not generated solely by rearranging the present text. It includes detector registrations, timings, images, spectra, trajectories, counts, comparison with physical standards, and the behaviour of constructed artefacts. The measurement does not arrive without interpretation, but it constrains the symbolic system by resisting some continuations and supporting others.

An exogenous result is never entirely free of language. Instruments are designed through models, signals are filtered, units are defined, and data are transformed. Nevertheless, the interaction introduces something that cannot be obtained merely by restating the current model.

It is the route through which the symbolic system can be perturbed by what it does not already contain.

3.2 Endogenous measurement

Endogenous measurement takes place inside language. It includes definition, comparison, algebraic rearrangement, classification, proof, semantic analysis, simulation, historical reconstruction, and the tracing of relationships across texts. These operations can be rigorous and productive. They are not inferior to exogenous measurement. They answer a different question: what can be discovered from within the currently available symbolic landscape?

The risk appears when endogenous success is narrated as direct discovery of nature. A derivation may show that one accepted expression can be transformed into another. A simulation may show that a chosen system of equations admits stable trajectories. A compiler-like formalism may reconstruct known quantities. None of these results, by itself, establishes that the chosen symbols or transformations are uniquely compelled by the world.

3.3 Their coupling

Scientific work is produced through repeated coupling between these two forms of measurement. Exogenous distinctions alter language. Language guides the construction of new instruments. New measurements refine definitions. Revised definitions expose previously hidden regularities. The process is dynamical rather than linear.

world interaction → registration → symbol → model → instrument → new interaction

No stage is foundational in isolation. Each stage inherits constraints and introduces new ones. The purpose of Finite Symbolic Mechanics is not to eliminate this circle but to make its finite trajectory visible.

4. What prediction means

The word prediction is frequently used for several different achievements. Clarifying these forms prevents a fitted reconstruction from being mistaken for an independent forecast, while also preventing genuine structural generalisation from being dismissed merely because it is not a novel numerical constant.

4.1 Retrodictive accommodation

A known observation is used to determine a parameter or select a form, and the completed model then reproduces the same observation. This can be useful. It shows that the model has sufficient expressive capacity and may provide a compact reorganisation of known results. It is not an independent prediction of the calibration target.

4.2 Model-internal consequence

A set of equations and initial conditions is specified, and a simulation or derivation shows what follows within that symbolic system. A bounded trajectory, bifurcation, stable orbit, or conservation relation may be a genuine property of the model. It becomes an empirical prediction only when linked to a prior measurement protocol capable of distinguishing it from alternatives.

4.3 Algebraic compatibility or reinterpretation

Accepted relations are rearranged into a form that aligns with a new conceptual framework. Such a result can reveal hidden structure or show that a new interpretation is not immediately inconsistent with an established constants network. It does not, by itself, generate a new physical quantity. Its achievement is compatibility and re-description.

4.4 Structural out-of-sample prediction

A relationship discovered in one system or subset is fixed and expected to recur in systems not used to form it. The prediction concerns shared form rather than an exact universal number. This is a legitimate and often important kind of prediction, especially in complex systems where scale, amplitude, and local parameters may vary while a functional structure persists.

4.5 Prospective quantitative prediction

The complete model and its parameters are fixed before a new measurement is available, and it specifies a numerical outcome or narrow range. This is the most familiar form of risky prediction, but it is not the only scientifically meaningful form.

4.6 Trajectory prediction

Finite Symbolic Mechanics adds another useful category. A theory may predict that future measurements will continue to stabilise onto a related finite symbolic trajectory. The claim is not that every value is identical, but that a measurable curvature, scaling law, residual structure, or relation persists under repeated and independent measurement.

Prediction is not a ceremonial label attached to an equation. It is a relation among provenance, prior constraint, permitted adjustment, and a future opportunity for the measurement to refuse the claim.

5. Re-reading the earlier Finite Mechanics programme

The earlier Finite Mechanics work is most useful when read as a research trajectory rather than as one finished physical theory. It contains several kinds of claim that should now be separated.

5.1 Galaxy rotation curves: from residual to recurrent structure

The galaxy rotation work began with the discrepancy between the observed rotation velocity and a velocity calculated from luminous mass. An implicit shell term was then reconstructed from that discrepancy. In generic form:

$$M_{\text{implicit,shell}}(r) = \frac{(v_{\text{observed}}^2 - v_{\text{luminous}}^2)r}{G}$$

The crucial step came later, when the scaling behaviour of that correction was examined across different galaxies. The reported recurrence of similar empirical structures across galaxies constitutes a structural prediction, provided that the later galaxies were not used to define the form and that the fitting procedure remained sufficiently fixed.

A residual that recurs across independent systems is not yet an object, but it is more than noise. It is a demand for a better symbolic and experimental account.

5.2 Mercury, other planets, and quasars

The initial Mercury calculation was retrodictive calibration. The later extension to other planets and quasars changes the status: once the method is fixed and carried to other empirical values, the question becomes whether the same family of correction terms lies on a coherent curve across distinct systems and scales.

5.3 The inversion of k and k'

The deeper intuition was that the conventional model required an additional functional relation connecting quantities treated as independent. The correction is to define one coefficient and its inverse once, preserve dimensions, and state explicitly the mapping:

$$m_{\text{implicit}} = k\,a, \qquad [k] = \text{mass / acceleration}$$

$$a_{\text{implicit}} = k'm, \qquad k' = 1/k, \qquad [k'] = \text{acceleration / mass}$$

5.4 Hydrogen stability without privileging an inherited mechanism

The proposed Finite Mechanics equations generated bounded or stable trajectories under selected conditions. This is a model-internal result. It shows that an alternative symbolic system can represent stable electron-like motion without importing the radiative-decay term used in a classical model. Bounded numerical motion does not establish a final physical account of hydrogen; it establishes what the selected equations can do.

5.5 Alpha and the network of constants

The fine-structure work rearranged accepted relationships. A representative compact relation was:

$$m_e\alpha^3 \approx e^2 f_R \mu_0^{3/2}\varepsilon_0^{1/2}$$

This is best classified as algebraic compatibility and reinterpretation.

6. Residual terms, implicit functions, and symbolic drag

When a compressed model fails to carry the complete finite trajectory of the measurements, a residual remains. Symbolic drag names the finite cost of compressing a thicker measurement trajectory into a simpler equation. The correction could be interpreted as missing matter, altered dynamics, unresolved geometry, or a representation artefact. The measured residual constrains these interpretations but does not automatically select one.

7. Finite representation and the failure of simple base invariance

As finite symbolic objects, different bases are not identical. They use different alphabets, lengths, adjacency relations, parsing rules, truncation behaviour, and geometric containments. Abstract value invariant $\neq$ finite representation invariant. A theory that claims to begin from a small set of integers therefore begins later than it appears; the integers arrive with an alphabet, a base, and a history of admissibility.

8. The noun as a slow verb or slow noun

A noun can be treated as a process whose visible change is slow relative to the measurement window of the observer:

apparent category $= f$(rate of change, measurement window, resolution)

Scientific objects such as mass, particle, field, constant, and law are stable enough for calculation because their internal histories and variations are compressed. Their usefulness does not prove that nature is divided into the same nouns independently of the measurement system.

9. How language holds an equation

An equation does not hold itself. It is held by a distributed historical and material system. The symbol alpha compresses spectroscopy, charge measurements, unit systems, and a history of theoretical use. The equation is a finite symbolic artefact held in a measurement loop.

10. Model pluralism without arbitrariness

A measurement underdetermines its final symbolic representation. Different languages can partition processes differently, select different bases, and compress trajectories at different points. Model pluralism remains accountable through distinctions preserved, measurements predicted, uncertainty carried, and capacity to guide new exogenous measurement.

11. The LLM as a new endogenous instrument

The large language model introduces a new kind of instrument. It operates within language and has no unmediated access to the world. Its value lies in traversing symbolic relations at unusual scale and speed, exposing assumptions, generating alternative trajectories, and making errors that can reveal inherited commitments. Discovery occurs in the coupled loop of perturbation, continuation, measurement, correction, and renewed construction.

12. A coupled method of research and correction

Inquiry is treated as iterative trajectory construction. The model generates continuations; the researcher measures them against prior work, internal commitments, mathematical coherence, and exogenous results. The human halting condition remains important.

13. A practical research protocol

1. State the symbolic model and its provenance.
2. Separate construction data from test data.
3. Classify the intended claim before examining the result.
4. Freeze the rule where prediction is claimed.
5. Carry dimensions, uncertainty, and units through every transformation.
6. Compare alternative symbolic models symmetrically.
7. Identify measurable discriminators.
8. Record the residual without prematurely naming it.
9. Examine base, alphabet, and finite precision.
10. Use the LLM as an endogenous probe.
11. Archive the full trajectory.
12. Apply an explicit halting condition.

14. Open questions and future work

- Formalising finite base dependence.
- Reconstructing the cross-system correction curves.
- Distinguishing bounded hydrogen models.
- Constants as measured relationship networks.
- Slow nouns in scientific language.
- Characterising the LLM instrument.

Conclusion to Chapter 1

Scientific knowledge is produced through finite models constrained by exogenous measurement and formed through endogenous symbolic measurement. Prediction must be described by provenance. Finite Symbolic Mechanics extends the lesson that base is not neutral under finite representation, nouns may be processes stabilised below a measurement threshold, and equations are compact artefacts held by marks, definitions, instruments, histories, and repeated measurement. The LLM enters this landscape as a new endogenous instrument whose value lies in changing the rate at which the present symbolic landscape can be traversed, questioned, and reconstructed.

Chapter 2: Anomalies, Incommensurability, and the Active Use of New Endogenous Instruments

Kuhn described scientific change largely in terms of the passive accumulation of anomalies until an existing paradigm could no longer contain them. The shift, when it came, often appeared as a gestalt conversion rather than a fully reasoned transition. That account remains useful as a historical description. It is less useful as a guide for deliberate work once new instruments appear that operate directly on the symbolic layer at scale.

Large language models constitute a new kind of anomaly. They did not arise from within any single scientific discipline as an unexpected experimental result. They arrived as a general-purpose endogenous instrument capable of generating fluent continuations, cross-domain analogies, and alternative symbolic trajectories at a speed and breadth previously unavailable. Because they produce apparent meaning rather than merely retrieving or rearranging existing statements, they create a distinctive form of incommensurability: outputs that are locally coherent within the current symbolic basin yet resist clean translation into the slower, more stabilised categories of established scientific language.

The difference between passive accumulation and active search matters. In the classical pattern, anomalies are noticed after they have already begun to strain the dominant framework. In an active programme, one deliberately deploys the new instruments to *surface* incommensurability — to make visible where two ways of stabilising nouns, two choices of base or admissible operation, or two compressions of the same measurements fail to map onto each other without residual drag. The error or the oddly fluent continuation is no longer treated primarily as a defect to be removed. It becomes a measurement of the current symbolic landscape and of the points at which that landscape may be ready for revision.

Such an approach requires the distinctions developed in Chapter 1. The coupled loop of perturbation, continuation, measurement, and correction becomes the operational method for searching. The protocol that separates claim types, freezes rules for prediction, and archives full trajectories supplies the discipline needed to prevent the rapid generation of alternatives from collapsing back into retrodictive accommodation or unexamined compatibility results. Finite representation effects and the dependence of accessible geometry on base and alphabet become relevant once one begins to ask whether a proposed new symbolic organisation survives changes of representational medium.

Kuhn wrote before the widespread availability of tools for studying nonlinear dynamics in symbolic systems, before explicit theories of compression and representational cost, and before instruments that could traverse inherited text at the scale now possible. His model of scientific change is therefore itself a finite construction, shaped by the endogenous capacities of its time. The appearance of powerful endogenous instruments does not guarantee an engineered epochal transition. It does, however, make the symbolic conditions of such a transition more legible and, to a limited but non-trivial degree, more open to deliberate work.

The practical question is no longer only whether anomalies will eventually force a shift. It is whether we can develop habits and instruments that allow us to locate, characterise, and sometimes exploit incommensurability before the accumulation becomes crisis. The same tools that generate fluent but partially opaque continuations can be turned toward making those continuations' points of friction with existing stabilised nouns explicit. That reversal — from passive recipient of anomaly to active inquirer into incommensurability — is the possibility opened by treating language and its instruments as objects of measurement in their own right.

Appendices

Appendix A. Working definitions

Model. A finite symbolic construction that organises measurements and supports transformations, explanations, simulations, or predictions. Its success does not make it identical with the world.

Exogenous measurement. A measurement produced through an interaction that introduces a distinction not obtainable solely by rearranging the present symbolic system.

Endogenous measurement. A measurement made within language or another symbolic system, including proof, definition, simulation, comparison, classification, and semantic reconstruction.

Epoch. A bounded configuration of available exogenous distinctions and available endogenous symbolic capacities.

Retrodiction. The reconstruction or accommodation of an already known result, especially where that result helped determine the form or parameters of the model.

Structural prediction. A prior expectation that a functional relation or measurable pattern will recur in independent systems not used to construct it.

Trajectory prediction. A prior expectation that later measurements will stabilise onto a related finite symbolic path, curvature, scaling family, or attractor.

Compatibility result. A demonstration that an accepted symbolic network can be rearranged or interpreted in a way consistent with a proposed framework, without independently predicting the quantities involved.

Symbolic drag. The residual correction or representational cost that appears when a compressed equation fails to carry the full finite trajectory of the measurements.

Slow verb / slow noun. A process whose change is below the temporal or symbolic resolution of an observer, so that it stabilises grammatically and conceptually as an object.

Finite base dependence. The dependence of symbolic length, closure, truncation, neighbourhood, computational path, or accessible geometry on the base used for finite representation.

Endogenous instrument. A tool that operates within the symbolic landscape and measures relations available there. An LLM is an endogenous instrument because it traverses language rather than directly measuring the external world.

Halting condition. The researcher's decision that a trajectory is sufficiently developed, sufficiently tested, no longer productive, or not worth the finite cost of further continuation.

Appendix B. Claim classification ledger

This ledger provides a compact classification of the examples discussed in Chapter 1.

Example	**Primary claim type**	**What it establishes**	**What remains required**
Galaxy rotation curves	Structural prediction	A recurrent correction family may organise independent galaxies	Frozen method, uncertainty audit, comparison with flexible baselines
Mercury calibration	Retrodictive accommodation	A coefficient can reproduce the known anomaly	Independent systems tested with the same fixed rule
Other planets and quasars	Candidate cross-system structural prediction	The correction terms may lie on a broader curve	Reconstruction of data, fixed inclusion criteria, held-out validation
Hydrogen stability	Model-internal consequence	The selected equations admit bounded trajectories	Distinctive measurable consequences and comparison with alternative models
Fine-structure rearrangement	Algebraic compatibility and reinterpretation	The constants network can be expressed in an FSM-aligned form	A genuinely independent measurement or prediction not used in the construction
Base dependence	Foundational mathematical conjecture	Finite instantiation may change under base conversion	Formal definitions, proofs, counterexamples, computational tests
Slow noun	Conceptual measurement model	Apparent object stability may depend on rate and observation window	Operational examples, historical studies, measurable semantic consequences
LLM instrument	Methodological claim	Symbolic traversal can support discovery and expose assumptions	Characterisation of bias, reproducibility, failure modes, and external validation

Internal provenance note. This document synthesises the July 2026 research discussion and an earlier set of Finite Mechanics appendices. Chapter 1 draws on work covering Mercury, hydrogen stability, galaxy rotation curves, dimensional relations for k and k', and rearrangements involving the fine-structure constant. Chapter 2 extends the framework to the active search for incommensurability using new endogenous instruments.