THE ARCHITECTURE OF DISTINCTION

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How Quantum Theory, Spacetime, and Consciousness Unfold from a Single Act

by

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PREFACE

What This Book Sets Out to Do

Twentieth-century physics produced two triumphs that do not fit together. General relativity describes gravitation as the geometry of spacetime (Einstein 1915) and accounts, to exquisite precision, for the fall of an apple and the bending of starlight alike. Quantum theory describes matter and radiation as amplitudes whose squares are probabilities (Born 1926; von Neumann 1932), and accounts, to equal precision, for the spectrum of the atom and the behaviour of every known particle. Each is among the most thoroughly confirmed theories in the history of science. Yet at the scale where gravitation and the quantum meet, the two descriptions contradict one another, and a century of effort has not joined them.

Beneath that famous incompatibility lies a quieter and deeper one. Physics relates magnitudes to one another with unrivalled accuracy and is silent about where the magnitudes come from. It tells us how mass bends spacetime and how a field evolves in time; it does not tell us why there is mass, or time, or space, or a world that carries such quantities at all. The equations presuppose the very stage on which they are written — a continuum, a set of states, a notion of before and after — and take that stage as given.

This book proposes that the stage itself can be reconstructed, and that the reconstruction has a long reach. Its central claim is that the architecture of the physical world, and the place of consciousness within it, unfold from a single act — the act of distinction, in the precise sense given it by Spencer-Brown (1969) — through a chain of formal steps each of which can be written down and checked. Not a metaphor of emergence, but an explicit sequence: this follows from that, and here is the derivation. The undertaking belongs to a recognizable tradition — Kant's (1781) question of what any possible experience presupposes, Weizsäcker's (1985) reconstruction of physics from elementary alternatives, Wheeler's (1990) conjecture that the physical world issues from yes-or-no distinctions — but it carries that programme through a single, explicit formal chain.

From that one act the book reconstructs, in order: the logic of two values and the self-reference that breaks it; the non-commutative algebra that two incompatible distinctions must obey; the geometric realization of the imaginary unit and the canonical commutator of quantum mechanics; the Schrödinger equation and the act of measurement; the emergence of spacetime, its three spatial dimensions and one temporal direction (the number three under named consistency conditions, the signature in form), and the Einstein equation of gravitation as an exact geometric identity, its physical coupling — Newton's constant — an openly named calibration; relativistic quantum field theory, in which the two operations of the mark — calling and crossing — become the two kinds of matter, bosons and fermions, with Pauli's exclusion principle and the Dirac equation following from the algebra of crossing, with two structural selections named where they enter; the dissipative form of the same dynamics, which coincides with Giuseppe Vitiello's doubled quantum field theory and yields the arrow of time as a structural consequence rather than an assumption; the gauge group of the Standard Model and the geometry of its internal fiber, with three generations and the Higgs (existence with a witness; which geometry nature uses is not derived); cosmology, dark matter, and dark energy, and the black hole as a boundary of projection; and at last consciousness itself, and the eternal, individuated self, located precisely within the same formal structure.

The ambition is large, and it is stated exactly. The claim is not that a single act forces the world in every detail and magnitude — three magnitudes, and two structural necessities, named where they enter, are supplied by measurement rather than derived. The claim is that the structural architecture of fundamental physics, and the formal place of the conscious self, become intelligible as consequences of one primitive together with a small number of named formal selections, identifications, and conjectured bridges — a conditional architecture whose every link is tagged, so that scrutiny knows exactly where to press. What such a reconstruction offers is not a foundation that compels the world into being, but a connected formal path that makes its structure intelligible — and that shows physics and mind to be two readings of one architecture rather than two unrelated facts.

The book is written to be readable without prior physics and without prior mathematics — though not without slow reading; the compression is real even where the prerequisites are none: every mathematical idea is introduced where it is first needed — technical words that appear in this Preface before their chapter are promises, not presuppositions, in a short framed passage that the practised reader may skip and the newcomer will find exactly where it is wanted, and the reasoning is meant to be followed by anyone willing to think carefully, one step at a time. Readability, however, is not verifiability: the book's formal claims require — and invite — mathematical and physical scrutiny, and the Derivation Ledger exists precisely so that scrutiny knows where to press. We begin where the construction begins: not with matter, not with space, not even with number — but with the act of drawing a distinction.

OVERVIEW

The Plan of the Book

The book follows one arc in ten parts. The first three carry the construction from the act of distinction to the mathematics of quantum mechanics; the next four unfold the full physical world — spacetime and gravity, relativistic quantum field theory, the Standard Model, and cosmology; the last three reach life, consciousness, and the empirical edge. Each part rests only on those before it.

Part I — The Ground: Distinction and Its Space

1 The Reconstructive Question and the Act of Distinction · *M_s, Φ, the threefold content*

2 The Calculus of the Mark · *calling and crossing; re-entry; the imaginary state*

3 The Place of the Subject · *polycontexturality; the proemial relation*

Part II — From Logic to Mathematics

4 Non-Commutativity: The Algebra of Distinctions · *$[A_i, A_j] \neq 0$*

5 The Symplectic Form and the Complex Unit · *ω; $A = g_0^{-1}\omega$; the polar J; $J^2 = -1$*

6 Deformation and the Weyl Algebra · *$[q, \pi] = c\cdot 1$ ($\to i\hbar$); GNS; the Hilbert space*

Part III — The Tension and Its Dynamics

7 The Tension Functional and the Three Admissibility Conditions · $0 \in \nabla\Phi(\sigma^*) + N_C(\sigma^*)$; $[q, \pi]$ preserved; bounded decoherence

8 The Mother Equation: A Three-Term Law of Change · *drift, diffusion, circulation; the inevitability of an actual world*

9 The Construction of Time · *how the equation generates its own parameter λ*

10 The Two Regimes: Schrödinger and Measurement · *the regime parameter ε; reduction as dynamical passage*

Part IV — The Emergence of Spacetime and Gravity

11 Projection: How Spacetime, Time, and Dimension Arise · *$d_{time} = 1$, $d_{space} = 3$, Lorentzian signature*

12 Curvature and the Einstein Equation · *the exact Gauss equation; the Einstein form; the geometric coefficient $\kappa_{geom} = 2/H^2vac$ derived, physical G open; the sign of Λ, and why the value of Φ cannot carry it*

Part V — Relativistic Quantum Field Theory

13 Calling and Crossing: The Two Statistics of Matter · *$\mathbb{Z}_2$ grading; exclusion; no in-between statistics*

14 The Wave Equations of Matter · *Klein–Gordon; Schrödinger recovered; Dirac as the square root*

15 Fock Space and the Vacuum · *second quantization; the zero-point boundary; inequivalent vacua*

16 Dissipation, the Doubled Algebra, and the Arrow · *Lindblad; the doubling as theorem; the electromagnetic arrow*

Part VI — The Standard Model and the Fiber

17 The Gauge Group from the Fiber · *four fences; fenced, not forced*

18 The Origin of Mass · *the Witten Laplacian; mass as spectral gap; the Higgs*

19 Three Generations and the Confrontation with the Numbers · *the index; thirteen for thirteen; Picard–Fuchs*

Part VII — Cosmology and Irreversibility

20 Cosmology as Vacuum Drift · *the vacuum manifold; three sectors; the mirror*

The Book in Three Movements

First movement — the Act. Everything begins with one operation: the drawing of a distinction. Its two laws, its re-entry into itself, and its threefold content — values, relations, self-reference, the selected organizing architecture — build the space of all possibility, M_s, carrying exactly one posited ruler and nothing else physical at all. Parts I and II turn this single act into an algebra.

Second movement — the Equation. Three transcendental conditions — identity, temporality, distinction — select, within the finite local Markov class fixed in Chapter 8, one normal form for the law of change: the Mother Equation, with one term per condition (the three-term architecture itself a selection, not an exhaustive count — Remark 1.5). From its regimes and its derivatives the equations of physics unfold: the Schrödinger equation from its circulation, the Dirac equation as the odd sector's forced square root, and the Einstein-form geometry from the curvature of the one tension landscape — each with its conditional floors recorded, line by line, in the Derivation Ledger. Parts III through VII walk this road.

Third movement — the Projections. The same architecture is then read three times over: as the physical world, whose spacetime, matter, and cosmos Parts IV through VII reconstruct; as the living and knowing world, where sustained circulation becomes life and epistemic circulation becomes mind; and as the self and its ground, where reflexive stabilization becomes the individuated self and the argument reaches consciousness and the eternal Self. Parts VIII and IX carry this third reading, with their distinct evidential standing marked where they begin. Terminology is held in three registers throughout: the Unprojected Self names the formal object — the invariant on the source side; the individual self names its projected appearance under an identity signature; and eternal, wherever the book uses it, is the interpretive reading of a derived unboundedness (Theorem 26.3), never an added metaphysical predicate — and one reading the book does not intend is named at once: nothing in that unboundedness asserts surviving memories, continuing biography, or a doctrine of comfort; what persists is an invariant, and Chapter 27 states exactly which.

One act, one equation, three readings: that is the whole book in one line, and the chapters exist to earn it.

PART I

The Ground: Distinction and Its Space

CHAPTER 1

The Reconstructive Question and the Act of Distinction

Where this part stands

Established: nothing yet — the book begins beneath establishment. The act of distinction is taken as primitive; its two symmetric places are declared (§1.3), and value scale, tree, and tension arrive each with its status tag.

Assumed: the act itself; the value interval, under four named requirements; the level-blind weights of the tree.

Ahead: this part builds the space of configurations and its logic; the first genuine theorems arrive with the ladder classification of Chapter 3, where the book's single conjectural bridge is isolated.

1.1 The question physics does not ask

A physical theory is a machine for relating quantities. Give it some numbers — a mass, a charge, an initial position and velocity — and it returns others: where the body will be a second from now, what light an atom will emit, how sharply a ray will bend as it grazes the sun. The triumph of physics is the accuracy of these relations. Quantum electrodynamics predicts a certain magnetic property of the electron to twelve decimal places, and experiment confirms it (Hanneke, Fogwell & Gabrielse 2008). No other human endeavour relates its quantities so well.

And yet a theory that relates quantities does not, and is not built to, explain why there are quantities to relate. It takes for granted a world already furnished with the things it speaks of: a space in which positions are defined, a time through which evolution runs, a collection of possible states over which probabilities are spread. These are the theory's stage, not its subject. Ask a physicist why there is space rather than no space, why time has a direction, why the world admits a notion of state at all, and you have stepped off the stage and into a different kind of question.

This book asks that different kind of question, and asks it in a disciplined form. It does not ask, in the first instance, what the laws of nature are. It asks what must already hold for there to be laws of nature at all — what minimal structure any world must possess before it can carry quantities, states, and dynamics. A question of this shape is called reconstructive. It treats the finished physics not as the starting point but as the destination, and works backward to the least from which that destination can be reached.

The form of the question is old. Immanuel Kant (1781) asked what must be presupposed by any possible experience; Carl Friedrich von Weizsäcker (1985), in his programme of an Ur-theory, asked what must be presupposed by any empirical decision, and tried to rebuild physics from the elementary yes-or-no alternatives that any measurement already involves; John Wheeler (1990) pressed the same intuition in the slogan that every physical entity derives from binary answers — it from bit. The present book stands in that lineage, but it carries the programme through a specific formal chain, and it holds itself to a strict standard: a reconstruction is worth precisely as much as the formal transitions it can actually exhibit, and not a step more. A story that speaks its way from a first principle to the world, without showing the steps, has explained nothing. We will therefore insist on writing every transition down as a formal link, and on marking, at each link, what is forced and what is merely supplied.

1.2 What it means to begin from the ground up

To begin from the ground up is to begin with something that presupposes nothing physical. This is a severe requirement, and it is worth feeling its severity. We may not begin with space, for space is to be reconstructed, not assumed; to help ourselves to it at the start would be to smuggle in the conclusion. We may not begin with time, for the direction and even the existence of time will turn out to be results, not premises. We may not begin with number — not even with the counting numbers — for we will see the number systems themselves grow out of the construction. We may not begin with matter, with energy, with probability, with a Hilbert space, with a manifold. Each of these is a structure we intend to reach, and so none may be a structure we start from.

When everything physical, spatial, temporal, and numerical has been set aside, what is left to begin with? The answer this book gives is that one thing remains, and that it lies beneath each of the structures we have just renounced: the act of separating one thing from another. Before anything can be counted, one must be told from another; before there can be a place, there must be a here set against a there; before anything can be said to exist, it must be marked off from what it is not. This act of marking off — of drawing a boundary that makes a difference, in Bateson's (1972) phrase — is the act of distinction. It is the primitive of the whole construction.

1.3 The primitive: the act of distinction

We follow here George Spencer-Brown, whose book Laws of Form (1969) showed that a complete formal calculus can be unfolded from a single instruction: draw a distinction. To draw a distinction is to cleave a whole into two regions by a boundary. The two regions leave nothing over and overlap in nothing: together they are the whole, and between them there is no third place. This is the entire content of the primitive, and its poverty is its strength — there is almost nothing in it to presuppose; even names for the sides are not in it.

> **Definition.** ***Distinction*** — the elementary act of drawing a boundary that divides a whole into two mutually exclusive, jointly exhaustive regions. Where notation needs a name for the sides, we follow Spencer-Brown in calling one of them marked — a convention, and a provably idle one (Remark 1.3a below). The distinction presupposes no space in which the boundary would lie — spatiality will instead be built up from the repeated drawing of distinctions — and no time in which the act would occur; succession will arise only when distinction is applied to its own results.

Remark 1.3a (The mark is a pen, not an ontology). [Derived — the flip symmetry, verified symbolically and numerically; the mature statement §35.1's]

The convention just declared — one side to be called marked, where notation needs names — is Spencer-Brown's, and the next chapter will use his calculus in full. The reader should know from the outset what Chapter 35 will establish with full care — the asymmetry belongs to the pen, not to the act. What the construction uses, from here to the last chapter, is only the symmetric content: two regions, mutually exclusive, jointly exhaustive, and the must-differ between them. Which side is called marked is convention, and the convention is provably idle. The activity of a distinction satisfies

$$\chi(1-\sigma) = \chi(\sigma) \;\Rightarrow\; \Phi(\dots,1-\sigma_i,\dots) = \Phi(\dots,\sigma_i,\dots)$$

so the tension landscape is invariant under exchanging the two ends of any distinction's value scale, $\chi(1-\sigma) = \chi(\sigma)$ — and with it the stationary balance and the drift–diffusion dynamics, which carry the exchange as a symmetry (verified symbolically and numerically: evolving and then flipping equals flipping and then evolving, $F\circ E = E\circ F$, to machine precision). Nothing downstream ever asks which end is which; both ends are rest, and only the open middle carries load. Said in Chapter 3's vocabulary: the tension is a kenogrammatic functional — it reads the pattern of difference, not the names of the values; the flip symmetry is value-abstraction dynamically enforced. Two further qualifications ride along. First, this chapter introduces places, values, and network almost in one breath, for expository speed; their true stratification — the bare pair first (Chapter 3's kenogrammatic stratum), the value scale second, the network third — is established where it can be earned, in §35.1. Second, the mature statement of the beginning — two correlative places instituted under bare unlikeness, marked/unmarked a later typing — is §35.1's, protected there by the two no-go theorems of Remark 35.1a: the instituting act is representable by no self-map of the ground, and persistence arguments can never deliver the two. The early chapters may keep their pen; the reader should keep the difference between pen and world.

It is worth dwelling on how little has been assumed, because everything later depends on this economy. The boundary is not a line in a pre-existing space; it is, rather, the first source of what will later be called spatial separation. The act is not an event in a pre-existing time; temporal succession will appear only once the distinction begins to fold back on itself. The distinction is not a thing among things — not an object with properties — but an act, the most elementary act there is. And, crucially, it is not yet the act of any distinguisher. There is, at this stage, no subject who draws the distinction; the one who distinguishes will turn out, very much later and very much to the point of this book, to be itself a product of the act — a stable pattern that the act generates when it is applied to itself. We begin, then, not with a knower confronting a world, but with the bare operation by which knower and known will both come to be marked off.

Mathematical background — Set, element, map

Three notions suffice for this chapter. A set is a collection of objects considered together; the objects are its elements, and we write "$x \in M$" to say that x is an element of the set M. A map (or function) $f : A \to B$ is a rule that assigns to each element of a set A exactly one element of a set B; A is the domain and B the codomain. We write $\mathbb{R}$ for the set of real numbers — every point of the continuous number line — and $\mathbb{N}$ for the natural numbers 0, 1, 2, 3, … . That is the whole of the prior mathematics this chapter requires; each further idea will be introduced as it arises.

1.4 Self-application and the binary tree

The act of distinction has one property on which everything else turns: it can be applied to its own result. Once the whole has been split into two regions, each of those regions is itself a whole that can be split again. After one application there are two regions; after two, four; after d applications, two-to-the-d. There is no stage at which the act ceases to be applicable, for the result of distinguishing is always again something that can be distinguished. The operation never exhausts itself.

Carried out without end, this self-application generates a structure with a perfectly definite shape: a binary tree with countably many branch points, each node splitting into two. Nothing has been added from outside to produce it; the tree is the unfolding of the single act through repeated application to its own results. This is the first appearance of a theme that will recur at every level of the book — that rich structure can be self-generated from a single operation, requiring no external scaffolding. The space in which all of physics will later be reconstructed is, at bottom, this self-generated tree of distinctions, suitably completed.

1.5 The space of possibilities, M_s

Collect together every configuration that the unfolded tree of distinctions can be in — every complete assignment of a state to each distinction — and the result is the pre-coherent space of possibilities, written M_s. A single point of this space, denoted σ, is one entire such assignment: a complete specification of how every distinction stands. We call it pre-coherent because its points are merely possible — logically admissible configurations — and need not be configurations that any actual, coherent world realizes. M_s is the space of everything that could be distinguished, before the question of what is actually the case has been raised.

At first each distinction admits only two states — call them one and zero; the pen of §1.3 would say marked and unmarked. On that reading M_s would be the set of all infinite sequences of zeros and ones.

$$\mathcal{M}_s^{(0)} = \{0,1\}^{\mathbb{N}}$$

But this two-valued reading cannot be the final one, and the reason is decisive for everything that follows. We will require that a dynamics live on M_s — that configurations be able to change smoothly, that we be able to speak of rates of change, of slopes, of curvatures. A set of bare sequences of zeros and ones is too coarse for any of this: between zero and one there is nowhere to move. Stated so, the reason sounds like a demand made for later convenience; Remark 1.3″ below returns to this step and grounds it in the act itself — the primitive is a transition, and a space that contains only completed results has no room for its own primitive. One can prove — the proof is written out in §1.F — that the closed interval from zero to one, written [0,1], is the only way of filling in the gap once four requirements are named: that the degrees of each distinction be totally ordered (more expressed or less, with no incomparable pairs); that the two logical values sit as least and greatest elements; that the filled-in set be connected, with no jumps; and that it be separable, a countable family of degrees approximating every degree. Under these four, a classical characterization of the linear continuum forces [0,1] up to order-preserving homeomorphism. The four requirements, not the interval, are the content of the step: richer completions exist — probability simplexes, effect algebras, a whole Hilbert space per distinction — and each is excluded by minimality rather than by theorem, since each adds structure beyond the four desiderata. The construction takes the least filling that makes calculus possible, and the uniqueness is exactly relative to that least. Each distinction then carries not a bare bit but a continuous value σ_i somewhere in [0,1] — naturally read as the amplitude, or degree, to which that distinction is expressed. The space of possibilities becomes the set of all such assignments, an unbounded product of intervals, written $[0,1]^{\mathbb{N}}$. That the product runs over $\mathbb{N}$ — countably many distinctions, no more — is the tree once again: every distinction sits at some finite depth of refinement, the nodes of the binary tree are countable, and a 'distinction' beyond every finite act of refining would be one that no drawing ever reaches. This continuous filling-in is thus unique relative to four named desiderata — a theorem, proved in §1.F — while the desiderata themselves are, at this point in the exposition, minimality choices, stated rather than hidden — Remark 1.3″ supplies each of the four with a ground in the act itself, leaving only the exclusion of richer value-objects to minimality.

Mathematical background — Space, dimension, metric, the ℓ^2 distance

By a space we mean here a set of configurations together with a rule for how close any two of them are. The dimension of a space counts the number of independent directions in which one can move within it; a space is infinite-dimensional when no finite number of directions suffices. A metric is the rule of closeness itself — a way of assigning a distance to each pair of points. The metric used throughout is the ℓ^2 (read "ell-two") distance, the natural generalization of the Pythagorean theorem to infinitely many directions: the distance between two configurations $(\sigma_1, \sigma_2, \ldots)$ and $(\tau_1, \tau_2, \ldots)$ is the square root of the weighted sum of the squared differences, $\sqrt{\sum_i w_i (\sigma_i - \tau_i)^2}$, where the weights w_i temper the contribution of ever-finer distinctions. A configuration that differs from another in just one distinction lies a small distance away; one that differs in many lies farther.

This ℓ^2 distance is the whole of the geometry that M_s carries at the outset.

$$\mathrm{dist}(\sigma, \sigma')^2 = \sum_k w_k \, (\sigma_k - \sigma'_k)^2$$

We call the corresponding structure the background metric and write it g_0. It is flat — space, in the ordinary curved sense, has not yet appeared — and it is the same at every point. What M_s does not carry is just as important as what it does. It has no notion of length or angle in any physical sense, no preferred dimension, no distinction between a temporal and a spatial direction, no relation of before and after, and no causal order. All of these — physical distance, the number three for space and one for time, the Lorentzian signature that separates time from space, the very arrow of causation — will be results of a later step, the projection, and not features of the ground. M_s is, in the strict sense, pre-spatial and pre-temporal. One can show, further, that it is connected (any configuration can be continuously deformed into any other), compact (in the product topology the space is the Hilbert cube, the classical compact of infinite dimension, and the weighted metric of Definition 1.2 induces exactly that topology), and infinite-dimensional (the tree of distinctions never closes). The sense in which possibility never runs out is therefore dimensional rather than metric: the space is bounded and closed, yet no finite family of coordinates ever exhausts it — and where the programme's informal usage says "non-compact" in this connection, it is this dimensional inexhaustibility that is meant; the topological statement stands as corrected here.

Definition 1.1 (The space of distinctions). [Constructed]
Let $\mathcal{X} = \{D_1, D_2, \ldots\}$ be the countable family of distinctions generated by the binary tree of iterated distinction, and let $\mathrm{depth}(D_i)$ be the tree stage at which D_i first appears. The space of distinctions is

$$\mathcal{M}_s = [0,1]^{\mathbb{N}}, \qquad \sigma = (\sigma_1, \sigma_2, \ldots), \qquad \sigma_i \in [0,1]$$

each point σ assigning to every distinction its amplitude of expression: $\sigma_i = 1$ fully actualised, $\sigma_i = 0$ fully latent, intermediate values equally real (not probabilities — there is no observer on M_s — and not fuzzy truth values, which carry no dynamics). The completeness of a distinction is the identity $\sigma_i + (1 - \sigma_i) = 1$: the two sides jointly exhaust the form. M_s is connected (convex), Hausdorff, separable, and infinite-dimensional.

Definition 1.2 (The background metric g_0). [Posited — structural choice]
On M_s fix the weighted ℓ^2 inner product

$$g_0(u, v) = \sum_k w_k \, u_k v_k, \qquad w_k = r^{2\,\mathrm{depth}(D_k)}, \qquad 0 < r < 1/\sqrt{2}$$

with tree-graded, geometrically decaying weights. The tree carries 2^d distinctions at depth d, so $\Sigma_k w_k = \Sigma_d 2^d \cdot r^{2d} = 1/(1 - 2r^2)$, finite exactly on the stated range $r < 1/\sqrt{2}$ — at the canonical $r = ½$ the sum is exactly 2, as the check below confirms — and therefore every point of $[0, 1]^{\mathbb{N}}$ has finite norm: the metric structure contains the whole space, restricting nothing. g_0 is positive-definite, identical at every point, and flat — the single structural posit of the construction (Chapter 5 discusses its standing).

What the weights do, checked on the tree. Take the canonical dial setting $r = ½$, so that each distinction at depth d carries weight $r2d = 4{-}d$. The binary tree has $2d$ distinctions at depth d — the count doubles per level — so the total weight of the whole infinite tree is the sum over levels of $2d \cdot 4{-}d = 2{-}d$, and that geometric series adds to exactly 2.

$$\sum_d 2^d \cdot 4^{-d} = \sum_d 2^{-d} = 2$$

Finite — and the consequence is worth holding for a moment. The farthest apart two configurations can possibly be is when they disagree maximally, by the full unit, in every one of their infinitely many coordinates; their squared distance is then the total weight itself,

$$d_{\max}^2 = \sum_k w_k \cdot 1^2 = \sum_k w_k = 2 \;\Rightarrow\; \operatorname{diam}(M_s) = \sqrt{2}$$

so no two possible worlds are more than a ruler's length apart — which is the concrete content of the box's claim that 'the metric structure contains the whole space, restricting nothing'. Two more of the box's words, paid in passing. 'Flat' means the ruler is the same everywhere — translation-invariant, $d(\sigma+h, \sigma'+h) = d(\sigma, \sigma')$: the distance between two configurations depends only on their difference, never on where in the space the pair sits — nothing curves yet, because nothing yet exists to do the curving; curvature will be manufactured, much later, out of Φ. And 'identical at every point' is the same statement from the other side: g_0 is one fixed quadratic rule, not a field of rules. The number r itself is the construction's one dial — how steeply depth discounts — and any setting strictly between zero and $1/\sqrt{2}$ yields the same topology and the same theorems — the weighted distance, with weights summable exactly on that range, metrizes the product topology of the cube regardless of the dial's value; what the existence of the metric as such commits the framework to is weighed openly in Chapter 5.

Remark 1.2′ (Two analytic roles, kept apart). [Open]
One weight sequence is being asked to do two different jobs, and the two jobs pull in opposite directions. The first job is geometry, and it is done: for the ruler to reach every configuration, the total weight must be finite, $\Sigma\, w_k < \infty$ — decaying weights, as above, succeeding with total 2 by the computation in the text. The second job is integration. Part III will need to average over configurations — to integrate over M_s — and integrating over infinitely many coordinates requires a reference measure: the infinite-dimensional stand-in for the ordinary 'dx' of the calculus. One such measure exists outright — the uniform product measure $\lambda^{\otimes\mathbb{N}}$ on the cube, which Part III will in fact adopt — so the tension below concerns not the existence of a measure but one specific wish: a Gaussian construction whose covariance is the inverse metric. The standard construction of that kind is a Gaussian — a bell curve per direction, each with a prescribed variance — and the list of those variances is the measure's covariance. Here is the constraint that bites: a Gaussian over infinitely many directions is a genuine measure only when its variances have a finite total — the trace-class condition, 'trace' being nothing but the sum down the diagonal of the variance list. In the standard calculus the natural variance of each direction is the inverse of its metric weight — heavily weighted directions are stiff and fluctuate little — so the condition reads $\Sigma\, w_k^{-1} < \infty$ and forces the weights to grow without bound: precisely where the geometry forced them to decay. The one-line check: with the decaying choice above, $\Sigma\, w_k^{-1}$ sums $2^d \cdot 4^d$ over the levels and diverges instantly. No single sequence serves both masters. The framework therefore separates the roles — the decaying tree-graded sequence for the ruler, its inverse for the reference measure's variances — and records the open item precisely: not the existence of a reference measure, but the canonical compatibility of the chosen measure, the diffusion operator, the Dirichlet form, and g_0 — displayed here rather than buried.

Remark 1.2″ (The topology as a theorem: the algebraic route). [Derived — programme theorem, one named identification]
Everything in this chapter so far treats the space itself — $[0, 1]^{\mathbb{N}}$ with its topology — as the posited stage on which the construction stands, and Remark 1.3″ below will ground that posit in the act. The programme has now added the converse route (The Distinction Algebra), and it deserves reporting here because it changes the status of the stage. Give each distinction instance nothing but

the operational content of a gradable two-sided act, and take the algebra those operations generate. An algebra, here, is a collection of operations closed under adding, scaling, and composing; a C*-algebra is such a collection that is moreover closed under the adjoint † — the operation that reverses order and conjugates, $(ab)^\dagger = b^\dagger a^\dagger$ — and under limits in the operator norm ‖·‖ (the largest factor by which an operation can stretch what it acts on), the two tied together by the C*-identity

$$\| a^\dagger a \| = \| a \|^2$$

— the one equation that makes norm and algebra agree, and the reason the theory has no loose analytic ends. 'Universal' means: generated by the stated relations and nothing else. So: the universal C*-algebra (the operator-algebraic completion Chapter 6 introduces in full) generated by one positive contraction σ_k — positive: $\sigma_k = \sigma_k^\dagger$ with no negative part; contraction: $\|\sigma_k\| \leq 1$ — with full spectrum [0, 1], the spectrum of an element being the set of values it can exhibit,

$$\mathrm{spec}(a) = \{\lambda \in \mathbb{C}: a - \lambda\mathbf{1} \text{ not invertible}\}$$

so 'full spectrum [0, 1]' says precisely that the graded act has an interval's worth of room. Let compatible instances commute — $[\sigma_i, \sigma_j] = \sigma_i\sigma_j - \sigma_j\sigma_i = 0$, the order of application irrelevant — and form the commutative core — the sector with the incompatibility structure switched off. One route to it takes the inductive limit (the completed union of an increasing chain of finite stages) of tensor products (⊗, the algebraic joining of independent systems — Chapter 6's composition rule); commutative C*-algebras are nuclear — the tensor product admits only one norm-completion — so no choice of norm hides in the construction. That route, however, imports something the book does not derive until much later and states plainly as a posit — that independent systems compose by tensor product (Chapter 37 carries it as Necessity 5, posited) — and a topology recovered through an unnamed composition rule would be a weaker result than it looks. The composition-free route is available, and the theorem should be read on it: take directly the universal commutative C*-algebra generated by a countable family of mutually commuting positive contractions $x_n = x_n^*$, $0 \leq x_n \leq 1$, each of full spectrum, with no product rule assumed at all; Gelfand duality applied to that algebra returns $C([0, 1]^{\mathbb{N}})$ at once, and with it the same stage. The tensor-product presentation is then a convenience of exposition rather than a premise of the result, and the named identifications reduce from two to one: distinction instance ↔ positive contraction of full spectrum. The theorem: the Gelfand spectrum of this core — the space of its characters, the nonzero maps χ that preserve the whole structure, $\chi(a + b) = \chi(a) + \chi(b)$ and $\chi(a \cdot b) = \chi(a) \cdot \chi(b)$, each character being one consistent way of assigning a value to every operation at once — is homeomorphic (identified by a continuous bijection with continuous inverse: the same space in every topological respect) to $[0, 1]^{\mathbb{N}}$ with the product topology (convergence meaning convergence in every coordinate). The possibility space is not posited; it is recovered as the character space of the operation's own algebra. Its points are the pure states — the states that cannot be written as mixtures of others; Borel probability measures on it (probability assignments defined on all sets the topology can build) are exactly the states of the algebra — so the possibility measure is a state; a density exists only relative to a reference measure, which the construction has not yet supplied — the measure question of Remark 1.2′, to be remembered wherever ρ is written; (the programme has since named its selection: the symmetric product measure on the cube — the maximal-openness reference of the centre point — with the dynamics read on its absolutely continuous sector; a further named selection, of exactly the standing of the state choice, and the bridge premise under which the dynamical theorems of the sequel operate — since strengthened, but only conditionally: under level-blindness taken at full strength — invariance under every permutation of the refinement levels rather than their mere shift, together with ergodicity under finite permutations — the condition that the only events left unchanged by every finite reshuffling are the trivial ones — de Finetti's theorem forces an i.i.d.

product measure (extremality of the mixture), while Hewitt–Savage, a zero–one law for i.i.d. sequences, sharpens but cannot generate that independence. What this does not yet fix is the single-coordinate marginal: endpoint symmetry and mean ½ leave a family — for instance $½·\mathrm{Bern}(¼)^{\otimes\mathbb{N}} + ½·\mathrm{Bern}(¾)^{\otimes\mathbb{N}}$ is permutation- and end-symmetric yet not the fair product — so the uniform marginal $\lambda_{[0,1]}$ is a separate physical selection, not a corollary. Under that added marginal the symmetric product measure $\lambda_{[0,1]}^{\otimes\mathbb{N}}$ is the anonymous choice; shift-invariance alone would not have sufficed — periodic and Markov-correlated witnesses (Markov: each digit influenced only by its immediate predecessor) satisfy it while failing anonymity's intent — and the selection lives irreducibly at infinite volume, no finite digit-window enforcing it) and the decided configurations form a closed subset homeomorphic to the Cantor space $\{0, 1\}^{\mathbb{N}}$ — the space of infinite binary strings, totally disconnected, no path connecting distinct points — the binary skeleton recovered rather than assumed.

What changes, and what does not. The topology of M_s moves from posit to theorem, at the price of one named transcription identification — one distinction, one positive contraction with full spectrum, spec(a) = [0, 1] — of exactly the standing of Chapter 3's operator identification: named, not hidden. And 'full spectrum' is where the act-theoretic grounding of Remark 1.3″ plugs in: the algebraic route derives the space from what the operation generates, the transcendental route grounds why the operation has an interval's worth of room to generate it — the two arrive at the same topology from opposite ends, consequences meeting conditions, which is the strongest consistency check this chapter owns. And it assigns the algebra a role the reader will meet again in Chapter 3: what Günther is to the ladder — the independent witness that its axioms predate the wish — the operation's own algebra is to the stage: a second witness, arrived from the opposite end. Definition 1.2's metric thereby has its role delimited precisely: the geometric weights metrize exactly this product topology — the ruler measures a space that no longer needs the ruler in order to exist. What does not change: the measure on the space remains the open problem of Remark 1.2′, and the noncommutative extension of the same algebra — incompatibility switched on — is programme work in progress, carried there with its own open questions marked.

Remark 1.2‴ (The metric as a corollary: the ruler carried by the dynamics). [Derived — in the finite-dimensional and established regular Dirichlet-form setting; the infinite-cube extension (closability, regularity, strong locality, intrinsic distance, spectral-triple existence with the same Connes distance) Open]
Remark 1.2″ ended, deliberately, at topology: the stage exists without the ruler. The programme has since taken the second step, and it belongs here because it completes the sentence. From the generator A of the Mother Equation alone define the square field $\Gamma(f, g) = ½[A(fg) - f·A(g) - g·A(f)]$ — an algebraic expression: the product of the algebra and the action of A, with no coordinate, no gradient, and no metric entering the definition. In the smooth representation (the concrete realization as operators, in Chapter 6's sense) it evaluates to $D\langle\nabla f, \nabla g\rangle$ exactly, the tension Φ cancelling identically — Φ shapes the state and the spectrum and never touches the ruler. The intrinsic metric of the associated Dirichlet form — the supremum of $f(x) - f(y)$ over $\Gamma(f, f) \leq 1$ — is then the g_0-distance divided by $\sqrt{D}$; and it coincides with the distance the spectral triple reads from commutators, the two being a single construction by the theorem of Cipriani and Sauvageot (2003), derivations as square roots of Dirichlet forms. What is gained must be said with the same care as in 1.2″: the Mother Equation was written with the ruler, so recovering the ruler from its generator is a merger, not a creation — the assumption list shortens from stage, ruler, and dynamics to the pair algebra-and-form, whose class projection stability pins. The stage no longer needs the ruler in order to exist; the ruler no longer needs to be carried separately — the dynamics carries it. And what was long separately assumed — smoothness — is assumed no longer: under the finiteness criterion of Proposition 1.4 the tension is a continuous polynomial of degree four, hence real analytic (Proposition 1.4′), and the smoothness of the coherence sheet itself becomes a

theorem of the normal spectral gap in Chapter 11; what stays genuinely open at this joint is only the global selection among coherence components — the landscape, not the calculus.

1.6 The tension functional Φ

Not every pair of distinctions sits easily together. Two distinctions can be incompatible, so that expressing both at full strength at once involves a conflict — a cost that a fully coherent configuration would avoid. What incompatibility means, operationally, can be fixed now and will be unfolded in Chapter 4: two distinctions are compatible when both can be simultaneously fully sharp throughout — jointly settled not merely in some single configuration but on a complete family of them, so that either can be read without disturbance in any configuration adapted to the other, like two numbers written on one page — and incompatible when this fails: when the full determination of either constrains the other somewhere, so that no complete family holds both settled at once. The global wording is deliberate and load-bearing, and Chapter 4 will show why: a pair can share an isolated configuration in which both happen to be sharp and still be incompatible, so compatibility must be the throughout-notion, not the somewhere-notion. And note that the question 'are these two compatible?' is itself a distinction — a boundary drawn across a pair of D's own products — which is why the incompatibility structure is native to the second layer of M_s's content rather than imported from anywhere outside it. The measure of that cost is the tension functional, written Φ. It assigns to each configuration σ a single non-negative number, Φ(σ), which records the total conflict among the distinctions that σ expresses together.

$$\Phi(\sigma) = \sum_{i<j} I\left(D_i, D_j\right) r^{2d}\, \chi(\sigma_i)\chi\left(\sigma_j\right), \qquad \chi(\sigma) = \sigma(1-\sigma)$$

Three factors make up each term. The factor $I(D_i, D_j)$ records how incompatible that particular pair of distinctions is. The depth weight r^{2d} — with $0 < r < 1$ (in the canonical tree-graded construction $0 < r < 1/\sqrt{2}$, as in Definition 1.2) and d the depth of the deeper of the two distinctions in the binary tree of the earlier section — makes distinctions drawn ever finer contribute ever less, decaying geometrically with depth. Why geometric — here and wherever this book discounts depth, in the ruler of Definition 1.2 as in the tension being built now — is not a matter of convenience. Each step of refinement is the same act performed again: the drawing of a distinction within a distinction. A rule that discounted depth d by one factor and depth d + 1 by another would carry a mark telling the levels apart — precisely what the recursion of one act does not contain. A level-blind discount means the ratio of successive weights is the same at every depth, and that is the definition of geometric decay: $w_d = r^{2d}$, with the single scale r as the only freedom, a convention of the same standing as the labels 0 and 1. The bound $r < 1/\sqrt{2}$ of Definition 1.2 then stops being a wish for convergence and becomes the consistency condition of the level-blind rule with the tree it discounts: 2^d distinctions live at depth d, and the blind rule must not let their number outrun its discount. The reader will meet the same principle again, at the centre of Chapter 3, as the naturality condition on the proemial ladder — one act, recursively instantiated, its registered asymmetry required to be the same at every instantiation: there it selects the measure of the ladder, here it selects the shape of the ruler; there, as here, the requirement is adopted openly rather than found lying in the sources. And the activity χ(σ) = σ(1−σ) measures how undecided a distinction is: it vanishes when the distinction is settled either way, at σ = 0 or σ = 1, and is greatest when it hangs exactly in the balance, at σ = ½. So a pair contributes tension only while both its distinctions are incompatible and both remain open; the moment either is decided, that term falls silent. Tension, on this reading, is the conflict among distinctions that stay simultaneously undecided — and it is resolved, driven to zero, precisely by their becoming decided. The pairwise product form of the sum is the one selected by a short list of requirements — no tension when either partner is absent, additivity over independent subsystems, continuity, and symmetry — and the activity χ is singled out by the further requirement just described: that a decided distinction contributes no tension, so that deciding is what resolves conflict.

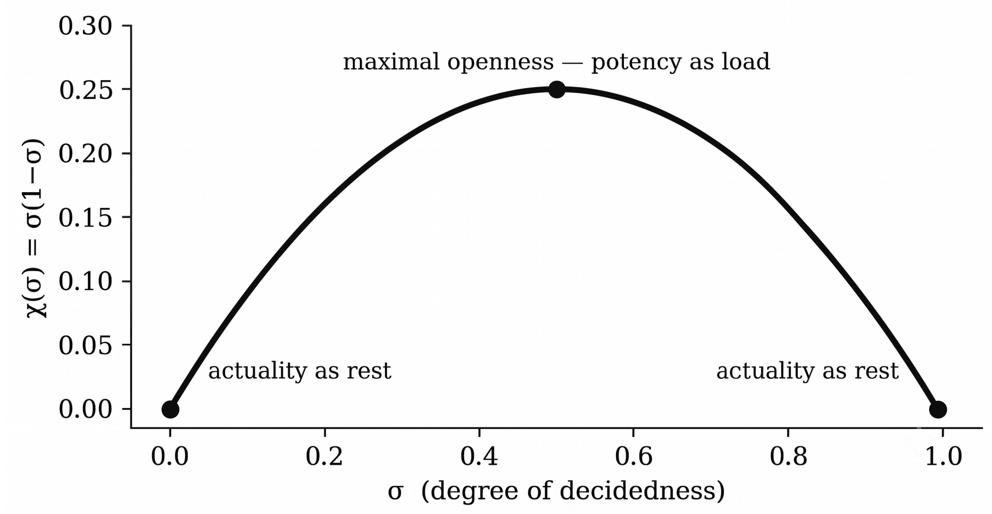

Figure 1.1 — *The tension of a single distinction: χ(σ) = σ(1−σ), maximal at the open centre and vanishing at the decided corners — potency as load, actuality as rest (§35.2′).*

The incompatibility coefficient I will, much later, reveal a familiar face: when the distinctions are realized as the observable quantities of quantum mechanics, I turns out to be proportional to the squared commutator of the corresponding operators — the commutator [A, B] = AB − BA being the measure of order-dependence, vanishing exactly when applying A then B is the same as applying B then A —

$$[A, B] = AB - BA, \qquad I \propto \| [\hat{A}, \hat{B}] \|^2$$

the precise measure of how badly two quantum observables fail to be simultaneously definite: commutator zero, jointly measurable; commutator nonzero, an irreducible trade-off between their definiteness.

$$I(D_i, D_j) \propto \| [A_i, A_j] \|^2 \qquad \text{(derived in Chapter 4)}$$

We do not assume that connection here; we will derive it. For now it is enough that Φ measures conflict, and that this single functional will turn out to be the source of magnitude for the entire physical world.

Definition 1.3 (The tension functional). [Constrained]

$$\Phi(\sigma) = \sum_{i<j} I_{ij}\, r^{2d(i,j)}\, \chi(\sigma_i)\chi(\sigma_j), \quad \chi(\sigma) = \sigma(1-\sigma), \quad d(i,j) = \max(\text{depth} D_i, \text{depth} D_j)$$

with $I_{ij} \geq 0$ the incompatibility coefficient of the pair (identified in Chapter 4 as the squared commutator $\|[A_i, A_j]\|^2$, a square — so the non-negativity posited here is redeemed there rather than assumed twice). The pairwise form is the selected minimal model under four requirements — no tension when either partner is absent; additivity over independent subsystems; continuity; symmetry under relabelling. Selected, not forced: additivity forbids couplings between independent systems, not higher interactions within one — a triple term $\Phi_3 = \Sigma\, a_{ijk}\, \chi(\sigma_i)\chi(\sigma_j)\chi(\sigma_k)$ satisfies all four requirements, so the restriction to pairs is a minimality choice, recorded as such — and the activity χ by the further requirement that a decided distinction ($\sigma \in \{0,1\}$) contributes no tension, so that deciding is what resolves conflict.

Remark 1.3′ (Why tension lives in the undecided — and not between facts). [Derived — given Definition 1.3 and the preservation of Chapter 7]
A reader meeting Definition 1.3 for the first time may find its central commitment backwards. Ordinary intuition places conflict between things that have committed — two decided distinctions, holding incompatible facts, grinding against one another — and expects the tension to vanish while everything is still open. The definition says the opposite: the activity $\chi(\sigma) = \sigma(1-\sigma)$ vanishes precisely at the decided values and peaks at the undecided midpoint, so the tension of a pair is greatest when both partners stand open, $\sigma_i = \sigma_j = 1/2$, and dies the moment either one decides. This deserves to be made explicit, because it is not a convention that could have gone the other way; it is the single orientation under which the rest of this book can happen.

Formally the mechanism is the product structure, and what it does to the forces is sharper than what it does to the values:

$$\frac{\partial \Phi_{ij}}{\partial \sigma_i} = I_{ij}\, r^{2d(i,j)}\, (1 - 2\sigma_i)\, \chi(\sigma_j) \;\Rightarrow\; \chi(\sigma_j) = 0 \text{ kills value and force}$$

One decided factor removes the pair's tension and the force it exerts on its partner: if $\sigma_j \in \{0, 1\}$ then $\chi(\sigma_j) = 0$, so $\Phi_{ij} = 0$ and $\partial\Phi_{ij}/\partial\sigma_i = a_{ij}(1 - 2\sigma_i)\chi(\sigma_j) = 0$ — the open partner feels no pull from this pair. The decoupling is one-directional, and that asymmetry is the exact formal content of resolution. The decided coordinate is not itself a free critical point: $\partial\Phi_{ij}/\partial\sigma_j = a_{ij}\, \chi(\sigma_i)\chi'(\sigma_j)$, and since $\chi'(0) = +1$ and $\chi'(1) = -1$, a decided factor is still drawn by an open partner — pressed against the boundary it already sits on. What holds a decided configuration in place is therefore the constraint $\sigma \in [0, 1]$, expressed as the no-flux condition $J\cdot n = 0$ at the wall, not a vanishing gradient. Deciding thus lowers the tension to zero and withdraws a distinction's pull on its partners, while the distinction itself is a boundary stationary point, not an interior one — the precise sense in which deciding resolves conflict.

Now the reader's intuition can be given its due, because it tracks something real that simply lives elsewhere in the architecture. Note first what the definition does not do: it does not penalize joint decision. For an incompatible pair with both partners decided, $\chi(\sigma_i)\chi(\sigma_j) = 0$ — the tension functional would be perfectly content. What forbids two incompatible distinctions from both deciding is not energy but kinematics: the preserved non-commutation of Chapter 7 — the central commutation relation

$$[q, \pi] = c \cdot \mathbf{1}, \qquad c \neq 0$$

which no admissible dynamics can decay to zero, so at least one pair of directions always retains a residue of jointly undecidable openness — already at work in Proposition 1.4 below, makes complete decision unreachable. The division of labour is exact, and it is the engine of everything that follows. Φ is the drive toward decision; the preserved circulation — the divergence-free component $\Omega\rho$ of the probability current, the part of the flow that turns without ever settling — is the obstruction that keeps the drive from ever finishing; physics is the standoff. The configurations on which the stationary density will concentrate — the pointer states — are the maximally decided ones compatible with that preservation: as decided as the world can get, holding exactly the residue of openness that non-commutation protects. The frustration between commitments that intuition expected is real — but it is a wall, not a force: it appears as the impossibility of a configuration, never as a cost assigned to one.

That the orientation of χ is forced, not chosen, is best seen by reversing it. Suppose the activity peaked at the decided ends instead — say $\tilde{\chi}(\sigma) = (2\sigma-1)^2$, maximal at $\sigma \in \{0, 1\}$ and vanishing at the midpoint.

Then every decided configuration becomes a summit of the landscape and the drift pushes off it into the interior — at a decided wall the inward force is $+4\ I_{ij}\ r^{2d}\ \tilde{\chi}(\sigma_j) > 0$ — so facts repel, the stationary density gathers at total indecision, no record forms, no measurement completes, and the minima of the landscape migrate from the decided lattice to the undecided midpoints, taking with them the very expansion points from which Chapter 18 will read masses:

reversed activity ⇒ decided configurations repel ⇒ no pointer states, no records, no masses .

A world with the reversed activity has no facts in it. The requirement that a decided distinction contribute no tension is therefore not one modelling taste among others; it is the unique orientation under which a classical record is an attractor rather than a repeller — and that consequence, not aesthetics, is what the tag on this definition is recording.

Ontologically, the definition is saying what tension is. It is not the clash of facts; it is strained co-possibility — the drawn bow, not the collided arrows. Two undecided, incompatible distinctions hold open between them a field of alternatives that cannot be jointly realized; the coefficient I_{ij} — later the squared commutator — measures exactly how much the deciding of one would prejudice the other, and the tension is the co-presence of that mutual prejudice while both still stand open. A decided distinction has left the space of possibility: it offers nothing for anything to conflict with. Actuality is tension-free; the strain of the world sits entirely in its potentiality-in-relation. The dynamics built on Φ will dissolve tension by deciding, while the circulation ensures the reservoir of the undecided never empties — a world that continually resolves without ever concluding. Where, in such an architecture, anything remains pending enough for a present to happen in it is a question Part VIII will inherit.

Remark 1.3″ (From teleology to transcendental ground). [Transcendental argument — conditional modeling theorem; the premises (retention, two-sidedness, order-density, completeness, separability) are named, not derived from the bare act]

Twice now this chapter has justified a commitment by what later chapters will need: the interval, because a dynamics must live on M_s (§1.2); the orientation of χ, because without it no records and no masses (Remark 1.3′). As grounds, such arguments are teleology — they explain why one would want the world we have, not why the construction had to be so. This remark converts both into transcendental derivations. The form of the conversion is exact: not ‘we need X for the goal’, but ‘X is a condition of the possibility of what is already actual’ — and the actuality invoked is nothing later and nothing physical, but the primitive of the book’s first page.

The anchor. The primitive is the act of distinction — the act, not the result — and the act is performatively undeniable: the sentence asserting that no distinction is drawn draws one, and the reading of this page is one, completed and still registered. That drawing happens, and that what is drawn stands, is therefore not a hypothesis added to the framework; it is its ground floor, available for transcendental use. To it the arguments below add only what is already posted elsewhere: that a distinction has two sides (analytic in the notion), that the law of change is local and positivity-preserving, and that it is fundamentally dissipative, $D \geq D\text{min} > 0$ — the framework’s one declared physical hypothesis. Nothing new is assumed anywhere in this remark.

The continuum, transcendentally grounded. Each desideratum of the filling-in theorem (§1.F) has an act-theoretic source, and with the sources supplied the hypothesis list stops being a taste. Endpoints: the two sides exist as completed acts — the anchor itself. Total order — any two degrees comparable, for every pair x, y either $x \leq y$ or $y \leq x$: drawing is one directed movement between two sides; ‘further drawn toward a side’ is comparable because there is one movement, not many. Connectedness, where the act’s reality bites twice: first, the primitive is a transition, and a state space containing only completed results contains no state in which drawing is underway — it deletes the primitive from the very ontology it grounds; so intermediate degrees exist. Second, among the degrees there can be neither gaps nor missing limits: a gap is a pair of degrees with nothing between, and a law local in the value cannot carry the act across it except by action-at-a-distance in the very variable the act moves — that grounds order-density — between any two degrees a third; and a bounded family of degrees without a supremum would be a drawing converging toward no degree at all — that grounds Dedekind completeness — every bounded family of degrees possessing a least upper bound, its supremum; the two together are exactly connectedness (§1.F, Step 1). The Pawula bound of Chapter 8 is the same fact seen from the density's side: what is local and positive moves by drift and diffusion, and diffusion needs somewhere continuous to diffuse. Separability — some countable family of degrees comes arbitrarily close to every degree: a degree beyond every countable refinement is a degree of expression that no sequence of drawings could ever single out — not a degree of distinction at all; the tree of refinements supplies the countable skeleton. Under (i)–(iv) so grounded, the theorem of §1.F forces [0, 1]; the labels 0 and 1 remain gauge; and only the exclusion of richer value-objects — simplexes, effect algebras, a Hilbert space per distinction — still rests on minimality, now phrased without teleology: not 'the least that makes calculus possible' but 'no more than the act itself puts there'.

The orientation of χ, transcendentally grounded on the same conditional footing. The anchor includes not only that acts happen but that their results register — remain in force long enough to be read; this page again. Under fundamental dissipation nothing stands unless the drift restores it: a value with no basin diffuses away, and a fact that diffuses away was never a fact. Decided values — and 'decided' is what 'drawn' analytically means: the act rests in a side — must therefore be attractors, so the tension landscape must take its minima on the decided set: $\chi(0) = \chi(1) = 0$. Positivity between: an interior zero would be a tension-free resting value that is neither side — a stable third value of a two-sided act, contradicting what a distinction is. Symmetry $\chi(\sigma) = \chi(1-\sigma)$: the two sides are exchangeable by relabelling, and labels carry no content. Within the class so forced — vanishing at the ends, positive between, symmetric — the quadratic $\sigma(1-\sigma)$ is the minimal polynomial representative: the class is derived; the representative is a convention of the same standing as the labels. And the no-go of Remark 1.3′ thereby changes role: it is no longer the ground of the orientation but its confirmation — the reversed activity contradicts not a wish for masses but the facticity of the very act that would have to state it.

What has, and has not, been achieved. The conversion does not conjure the world from nothing; transcendental derivations never do. They exchange 'because we want the consequence' for 'because it is presupposed by what is already actual', and the premises here are exactly four, all previously on the table: the performative facticity of the act; the two-sidedness of distinction; locality with positivity; fundamental dissipation. Nothing has been added; two things formerly posited have become conditional theorems once the named transcendental premises are granted — conditional, not absolute, since the premises are motivated by the act rather than entailed by it. Why anything is actual at all — why any act is performed — remains outside every derivation of this kind, and the book will not pretend otherwise: that residue is where argument ends, not where it failed. The method — conditions presupposed by coherent structure as such, not chosen — is the one the reader will meet at full strength in Chapter 7, where identity, temporality, and distinction select the law of change; this remark extends it down to the chapter's ground floor.

Remark 1.3‴ (The circle that is not vicious, and the order the act needs). [Derived — the reflexive structure named; the temporal layering made explicit]

Remark 1.3″ grounded the interval in the act, and the grounding invites two objections that deserve to be raised at full strength rather than left for the reader to trip over. The first: the space is generated by acts of distinction, and its structure was just justified by appeal to the act — is that not a circle? The second: if the act is drawn through real intermediate degrees, does the act itself take time — and would the possibility space then come into being in some transcendental temporal course?

The circle is real, and it is re-entry, not fallacy. A circle is vicious when the conclusion stands among the premises — when the act's characterization would be drawn from the completed space, as it would be if 'transition' had been defined as 'continuous path in [0, 1]'. Nothing of the kind was used. The characterization drew only on what precedes every space: that the act happens (the performative anchor), that it has two sides, that it is one directed movement, that it completes and its result stands. The direction of grounding runs from the actuality of the performance to the structure of the form — and performance and form are different categories, so no proposition is derived from itself. What remains — that the generated space must have room for its own generator — is not a defect but the fidelity of the transcription, and it is a figure this book has already made structural: the re-entry of Chapter 2, the form that contains its own act of indication. A possibility space that contains the act which generates it is re-entry at the level of the space itself — the signature of a self-grounding primitive.

The possibility space does not come into being. The genetic idiom — 'the act generates the space' — is reconstructive, not ontic: M_s is not the deposit of performed drawings but the form of the act as such, given with the act's possibility rather than accumulated by its performances, and the depth of the refinement tree is logical priority, not chronology. Nor could it be otherwise: if the space arose in a process, the arising would need a time before the space, that time its own space of possibilities, and so on without ground. Forms do not become; only actualizations become. There is, therefore, no transcendental temporal course for the genesis of the possibility space — because genesis is a category of actuality, and the space of possibility is not an actuality.

The performed act, by contrast, is ordered — and this is not an embarrassment but a confirmation. A drawing that is underway traverses the interior degrees along λ; Chapter 10 will say of measurement exactly this, reduction as dynamical passage. But λ is order, not time: it is the bare ordering of actualization — Chapter 8 is deliberate in not yet calling it time, and Chapter 9 earns its temporal credentials only afterwards, resolving on the way precisely the regress just raised: the generator of the dynamics, the field of tendencies, is built from λ-independent material and exists before anything is generated; λ enters as the parameter of the traversal, not as a presupposition of the field. The same layering settles the act. The interval belongs to the form and is time-free — it is the room the act needs, standing to the act as the generator stands to the flow; the traversal belongs to the performance and is λ-ordered; and that performances are ordered at all is already among this book's transcendental conditions — it is A2, the condition of temporality, of Chapter 7. The act needs order, not time. Remark 1.3″ used of the performance only that it is, never when. One may put the whole resolution in a grammatical figure: the interior of the interval is the present tense of the act, the endpoints are its perfect — the form contains both tenses as places while itself having none, and which place is actual is the business of performance alone.

Proposition 1.4 (Finiteness criterion and selection rule). [Derived]
Let N_d be the number of incompatible pairs of joint depth d, and suppose $I_{ij} \le C$. If $N_d \le A\cdot 2^{\kappa d}$ with $2^\kappa r^2 < 1$ — for the canonical $r = ½$: $\kappa < 2$, subquadratic growth in 2^d — then $\Phi(\sigma) < \infty$ for every $\sigma \in M_s$. Conversely — and the criterion must be stated by counting, since a naive appeal to 'infinitely many active deep pairs' is not sufficient and an earlier printing of this proposition said so wrongly. Write $M_d(\sigma, \varepsilon)$ for the number of incompatible pairs of joint depth d whose weights are bounded below, $I_{ij} \ge I_0$, and whose activities satisfy $\chi(\sigma_i)\chi(\sigma_j) \ge \varepsilon^2$. Then $\Phi(\sigma) \ge I_0\varepsilon^2\, \Sigma_d\, M_d(\sigma, \varepsilon)\cdot r^{2d}$, and the series diverges exactly when $\Sigma_d\, M_d(\sigma, \varepsilon)\cdot r^{2d} = \infty$. One active pair per depth does not do it: at $r = ½$ its contribution is $I_0\varepsilon^2\cdot 4^{-d}$, and the sum is finite. What suffices at quadratic growth ($\kappa = 2$, $r = ½$) is that the active pairs keep pace with the depth weight — $M_d(\sigma, \varepsilon) \ge c\cdot 4^d$ along an infinite set of depths whose contributions do not thin out — that is, a positive density of active pairs within the quadratically growing pair set. Mere undecidedness ($\chi > 0$) does not suffice: activities may decay, e.g. $\chi(\sigma_{\{id\}}) \sim 2^{-d}$, fast enough to keep Φ finite. Preserved non-commutation (Chapter 7) forbids complete decision but does not by itself deliver either the uniform activity bound or the required density of active pairs, so the non-projectability of quadratic-growth graphs holds under that added uniformity hypothesis and is otherwise [Open]: where it holds, divergent Φ means non-projectable.

Finiteness of Φ is a selection rule on incompatibility patterns, not a property to be engineered by the weight. Proof in §1.F.

Mathematical background — Functional, gradient ∇, minimum

A functional is a rule that assigns a single number to an entire configuration — here, to each assignment σ its tension value Φ(σ). The gradient, written ∇Φ, is the "arrow of steepest ascent": at every configuration it points in the direction in which Φ increases fastest, and its length says how steeply. Where Φ is at a local minimum — a valley floor of the tension landscape — there is no longer any uphill direction, and the gradient vanishes: ∇Φ = 0. The gradient also drives motion downhill: a configuration left to itself slides in the direction opposite to ∇Φ, toward lower tension, the way a ball rolls to the bottom of a bowl.

The configurations at which the gradient vanishes — the valley floors — have a name and a destiny.

$$0 \in \nabla\Phi(\sigma^*) + N_C(\sigma^*)\ \big(\text{interior: } \nabla\Phi = 0;\ \text{decided face: } J_\rho \cdot n = 0\big)$$

— the stationarity (pointer) condition. At interior configurations it is the ordinary $\nabla\Phi(\sigma^*) = 0$; on a decided face it is the constrained condition $0 \in \nabla\Phi(\sigma^*) + N_C(\sigma^*)$, which coordinatewise reads $\partial_i\Phi = 0$ where $0 < \sigma_i^* < 1$, $\partial_i\Phi \geq 0$ where $\sigma_i^* = 0$, and $\partial_i\Phi \leq 0$ where $\sigma_i^* = 1$. The reflecting no-flux law $J_\rho \cdot n = 0$ is a separate condition, imposed on probability currents at the boundary and not part of the pointwise definition.

They are called pointer states: the configurations in which the conflict among distinctions is most fully resolved, whether through compatibility or through decision. These pointer states will turn out to be exactly what we ordinarily call the classical, the actual, the definite — the settled outcomes a measurement leaves behind. And the downhill drift generated by ∇Φ, the steady slide of a configuration toward the nearest valley, will turn out to be one of the three ingredients of the single equation that governs all dynamics. The classical world, in this picture, is the set of valleys in a landscape of conflict among distinctions, and physical change is in part the rolling of possibility toward those valleys.

1.7 The threefold nature of distinction

We come now to the result that organizes the entire book, and that justifies its title. When the act of distinction is applied — to states, to pairs of states, and to itself — it yields three kinds of content, mutually irreducible. The three are not imposed from outside, but neither are they exhaustive: further applications exist — higher families, relations among relations, arbitrary nestings — and Remark 1.5 withdraws the exhaustiveness claim explicitly. The three named here are the organizing architecture this book selects, and everything built on the count is conditional on the selection. From these three kinds of content the three great themes of the book descend.

First, distinction applied to states yields the values of the distinctions, the family of quantities σ_i — what is the case, how strongly each distinction is expressed. From this descends identity: the classical, the definite, the pointer state. It is the world as settled fact.

$$\text{distinction of states} \ \mapsto\ \text{values } \sigma = (\sigma_i)$$

Second, distinction applied to pairs of states yields the relations among distinctions, the incompatibility structure I — how the distinctions stand to one another, which conflict and which agree. From this descends temporality, and from temporality, as the central chapters will show in full, the entire structure of quantum physics: non-commutativity, the imaginary unit, the Schrödinger equation, and — through the two operations of the mark — the division of matter into bosons and fermions.

$$\textit{distinction of pairs} \longmapsto \textit{relations } I(D_i, D_j)\ .$$

Third, distinction applied to itself yields self-reference, the re-entry of the form into the space it has drawn — the mark that marks itself. From this descends, as the final part of the book will argue, consciousness, and the individuated self that persists through change.

$$\text{distinction of itself} \;\mapsto\; \text{re-entry } f = \neg f \qquad \text{(Chapter 2)}$$

These three kinds of content — values, relations, self-reference — correspond one-to-one to three conditions that govern how the space of possibilities gives rise to an actual world, and to the three terms of the single equation that will govern all change.

$$\{\ \textit{values, relations, self-reference}\ \} \leftrightarrow \{\ (A1), (A2), (A3)\ \} \leftrightarrow \{\ \textit{drift, diffusion, circulation}\ \}\ \textit{(one-to-one; Chapters 7–8)}\ .$$

The threefold structure that runs through the whole of physics and on into the theory of consciousness is, in this way, traced back to the threefold nature of the one act: distinction of states, distinction of pairs, distinction of itself. Identity, temporality, and reflexion are not three separate principles bolted together; they are the three faces of a single operation applied in the three ways this architecture selects.

Remark 1.5 (The threefold content as organizing architecture). [Posited — selected architecture; exhaustiveness withdrawn]
The act of distinction can be applied to states (yielding values σ), to pairs of its results (yielding incompatibility relations I), and to its own boundary (yielding re-entry patterns R). An earlier version of this remark claimed that these exhaust the possible applications — that there is no fourth object for D to act upon. That claim is withdrawn: the act can equally be applied to triples and higher families, to relations among relations, to maps between systems, and to arbitrarily nested iterations — the programme's own bracket-depth construction produces exactly such a tower. What is true is weaker and is what the book actually uses: the three contents named here are mutually irreducible, and they are the organizing architecture this book selects; their one-to-one correspondence with the three admissibility conditions and the three terms of the Mother Equation is established in Chapters 7 and 8.

And one wording in this section will be sharpened five hundred pages on; the sharpening is planted here to prevent a misreading. 'Yielding re-entry patterns R' names the third content as it appears registered in the space — the address the architecture reserves for self-application. It does not say that re-entry is a static property of particular distinctions: a registered pattern is, once registered, a value like any other, and the book will prove in its reflexive part (Remark 26.2c) that what actually carries reflexive standing is never a coordinate at rest but a mode of the dynamics — precisely the circulation with which this very display pairs the third content. The correspondence above is thus more literal than it first appears: values live in the landscape, relations in its couplings, and re-entry in the flow. Whether the registered address and the living mode coincide is a question the book keeps open where it arises.

One consequence of this threefold structure deserves to be named here, although the argument for it belongs to a later part of the book, because it sets the book apart from most attempts to relate physics and mind. The long-standing puzzle of how conscious experience could arise from physical process — the so-called hard problem of consciousness (Chalmers 1995), the question of why there is something it is like (Nagel 1974) to be a physical system at all — appears in this framework neither as something to be solved by a cleverer physics nor as something to be explained away, but as something to be located. The gap between physics and experience turns out to be the categorical gap between the second kind of content, which generates physics, and the third, which generates self-reference. It is not a gap that richer physics could close, because it lies between two categorically distinct modes of one and the same act. Where exactly the line falls, and why it cannot be crossed by adding more physics, the final part will set out in detail. We note here only that the line exists, that the framework draws it precisely, and that drawing it — rather than blurring it — is part of what the construction achieves.

1.8 The road ahead

Remark 1.5a (What the points are, and what they are not). [guard — placed here so that five hundred pages are not read under a picture Chapter 4 will qualify]
This section has spoken of points: a configuration σ, a complete assignment of a degree to every distinction. The picture is correct, and it is correct of something specific — the commutative core just constructed, the sector in which every pair of distinctions is compatible. A point is a simultaneous valuation, and simultaneous valuations exist exactly where everything commutes. Chapter 4 will show that distinctions in general do not commute, and once an incompatibility is enforced rather than merely permitted, the full structure has no points at all: no assignment gives every distinction a value at once, not because the values are hidden but because a joint valuation is the wrong kind of object to ask for — just as position and momentum, in the physics this book will reach, admit no common sharp assignment — indeed Chapter 4's canonical pair already admits no read-out at all, since a read-out kills every commutator and would have to send c·1 to c. The cube of this section does not thereby become wrong. It becomes the shadow: the character space of the commutative core, the part of the structure a point can see. What no point can see is the entire relational content, everything carried by commutators — §35.2′ records the general form, that points annihilate every bracket depth — and the reflexive structure of Part IX will live precisely there.

What replaces the missing points is already on the page: the density ρ. A reader should hold it, from the beginning, as a state on the algebra of distinctions rather than as a distribution over a set of points — an assignment of an expectation value to every observable, linear, positive, normalized — where 'expectation value' must be heard in this book's register: on M_s it is a weight of potency in the sense of §35.2′, not a credence, since no observer lives there and nothing is unknown; probability is what these weights become under projection and conditioning (Chapter 8), not what they are. On the commutative core the two readings coincide exactly, a state there being nothing but a probability measure on the cube, and everything this book does with ρ on M_s is done in that sector and is correct as written. The gain of the sharper reading is that it survives where the points do not: states exist on the full noncommutative structure, and ρ keeps its meaning there — registering, in expectation values, relational content that no configuration could display. Possibility, in this architecture, is therefore carried by valuations-in-expectation, not by a warehouse of fully decided worlds; the cube is the ledger of what the compatible shadow can show, and ρ is the bookkeeping of the whole. [Constructed — the reading; the coincidence of states with measures on the core is Theorem 34.2's Riesz–Markov rider; the blindness of points to bracket depth is §35.2″s record, and the characterlessness of the central pair follows in one line from Chapter 4.]

The ground is now in place: a single act, its self-generated space of possibilities M_s, a measure of conflict Φ upon that space, and the threefold content from which physics and mind will both descend.

$$\text{act} \;\rightarrow\; \mathcal{M}_s = [0,1]^{\mathbb{N}} \;\rightarrow\; (g_0, \Phi) \;\rightarrow\; \{\text{values, relations, re-entry}\}$$

Everything that follows is the unfolding of this ground along the arc set out in the overview. The next two chapters complete the foundations. Chapter 2 shows that the calculus of the mark is not merely analogous to a two-valued logic but is one, and that allowing the mark to re-enter the space it draws forces a move beyond two values — producing the oscillating, imaginary state that will reappear, far downstream, as the imaginary unit of quantum mechanics. Chapter 3 follows Gotthard Günther (1959, 1962) in asking where, within a logic, the subject who uses it can stand, and finds in his many-contextured logic the asymmetry that the algebra will carry forward.

From there the construction climbs. The relations among distinctions become a non-commutative algebra — one in which the order of application matters, $ab \neq ba$ in general — (Part II); that algebra carries a symplectic form — an antisymmetric pairing $\omega(u, v) = -\omega(v, u)$, the structure that turns energy into motion — a complex structure — an operator J with $J^2 = -1$, the geometric role of the imaginary unit — and, as its unique stable deformation at first order, the canonical commutator of quantum mechanics, $[q, \pi] = c\cdot 1\!\!1$, from which the Hilbert space — a complete vector space with an inner product $\langle\cdot,\cdot\rangle$, the arena of quantum states — is built. The tension functional supplies magnitude and, with the three admissibility conditions, the single three-term equation we will call the Mother Equation (Part III); its two regimes are the Schrödinger evolution and the act of measurement. A projection from the space of possibilities to a manifold — a space that near every point looks like ordinary $\mathbb{R}^n$ — of actualities yields spacetime, its dimension and its signature (the sign pattern $(-, +, +, +)$ that separates the one time direction from the three of space), and the Einstein equation of gravity (Part IV). The two operations of the mark, calling and crossing, become the two kinds of matter, and the same dynamics that gives the Schrödinger equation gives, by a kind of square root, the Dirac equation of relativistic matter; its dissipative form coincides with Vitiello's doubled quantum field theory (Vitiello 1995, 2001) and delivers the arrow of time (Part V). The internal fiber of the projection — the space of source-degrees attached to each projected point — carries the gauge structure of the Standard Model and the geometry that fixes three generations and the mass of matter (Part VI) — existence with a witness; which geometry nature uses is not derived. The same dissipative vacuum dynamics drives cosmology, gives dark matter a structural home and dark energy a dynamics — the magnitude of the cosmological term remaining open — and dissolves the black-hole information paradox (Part VII). And the third kind of content, self-reference, carries us to consciousness and to the eternal, individuated self (Parts VIII and IX), before the final part gathers the framework's empirical predictions and names exactly the three magnitudes it does not derive (Part X).

We turn now to the first of these steps: how the act of distinction becomes a logic.

1.F Formal development: finiteness of the tension

Proof of Proposition 1.4. The activity is bounded, $0 \leq \chi(\sigma) \leq 1/4$ (maximum at $\sigma = 1/2$), so every pair term is bounded by $I_{ij}\, r^{2d}\cdot(1/16) \leq (C/16)\cdot r^{2d}$. Grouping the sum by joint depth,

Proposition 1.4′ (Cylindrical and analytic regularity). [Derived — under the convergence condition of Proposition 1.4]

The cylinder functions — functions of finitely many distinction coordinates, smooth in each — form a unital (containing the constant 1), point-separating (any two distinct configurations are told apart by some function) differential algebra, uniformly dense in $C(M_s)$ — every continuous function approximated to any accuracy — by Stone–Weierstrass, the classical theorem that such families suffice, closed under partial derivatives, and carrying the direct-limit cylindrical de Rham complex — the ladder of differential forms, d: functions → 1-forms → 2-forms → ..., with $d^2 = 0$. On it the tension is better than smooth: writing $a_{ij} = I_{ij}\, r^{2d(i,j)}$, the finiteness criterion gives $\Sigma\, a_{ij} < \infty$, and since $\chi(x_i)\chi(x_j)$ splits into monomials of degrees two through four, Φ extends to a continuous polynomial of degree at most four on the bounded sequences — real analytic, with all derivatives above the fourth vanishing identically. The background form go is likewise continuous, and restricts to an ordinary Riemannian metric (positive-definite: every direction has positive length) on every finite-dimensional coherence sheet. Smoothness of the tension is therefore not an independent premise; it is a consequence of the same summability that makes Φ finite. One qualification: this supplies a differential calculus relative to the distinguished distinction coordinates — it does not claim that the Hilbert cube carries a unique smooth structure determined by its topology alone.

$$\Phi(\sigma) \;\le\; \frac{C}{16}\sum_{d} N_d\; r^{2d}$$

$$N_d \le A\,2^{\kappa d} \;\Rightarrow\; \text{convergent} \Leftrightarrow 2^{\kappa} r^2 < 1 \Leftrightarrow \kappa < 2\log_2(1/r)$$

With $N_d \le A\cdot 2^{\kappa d}$ the summand is bounded by $A(2^{\kappa} r^2)^d$, a geometric series: it converges precisely when $2^{\kappa} r^2 < 1$, that is $\kappa < 2\cdot\log_2(1/r)$; for r = ½ this reads κ < 2 — the pair count must grow subquadratically in the 2^d nodes available at depth d. For the converse, take the all-pairs graph at r = ½: $N_d \sim (2^d)^2$ gives summands $\sim (2^2\cdot 1/4)^d = 1$, and at any configuration with σ_i bounded away from {0,1} on infinitely many deep pairs each term is bounded below by a fixed positive number, so the series diverges, Σ → ∞. Finiteness on such graphs would require complete decision of the deep distinctions, which condition (A2) of Chapter 7 forbids for admissible structures; hence no admissible pointer states exist and the pattern is non-projectable.

Two readings close the section. Analytically, convergence is a joint condition on weight decay and graph density — no weight alone secures it, since quadratic pair growth defeats any geometric decay at its critical rate. Physically, the dichotomy finite/divergent is the selection rule of Chapter 7: exactly the convergent incompatibility patterns possess valleys, and exactly they project to worlds.

One scope limit, stated plainly. *Absolute convergence of the coupling sum, $\Sigma_{\{i<j\}}\, a_{ij} < \infty$, secures Φ as an analytic scalar on the full cube, but it does not by itself secure a gradient in the weighted state space: the go-gradient has components $(\nabla_{\{go\}}\Phi)_i = \partial_i\Phi \,/\, w_i$ and squared norm $\|\nabla_{\{go\}}\Phi\|^2_{\{go\}} = \Sigma_i\, |\partial_i\Phi|^2 / w_i$, and because the weights w_i decay, division by w_i can push this sum to diverge even when $\Sigma\, a_{ij}$ converges. Existence of the go-gradient on the full space is therefore a separate hypothesis, $\Sigma_i\, |\partial_i\Phi(\sigma)|^2 / w_i < \infty$ on the relevant state region (ideally uniformly along the finite truncations). Where that summability is not established, every differential statement built on $\nabla_{\{go\}}\Phi$ — the drift of the Mother Equation and the projection map included — is to be read as holding on the finite cylindrical truncations, on which the gradient exists unconditionally, and as an open bridge on the full space. This is one of the localized bridges recorded in the ledger.*

Uniqueness of the interval (the filling-in claim of the chapter), the steps written out. The four desiderata: (i) the degrees of one distinction form a totally ordered set L; (ii) L has a least and a greatest element — the two logical values; (iii) L is connected in its order topology; (iv) L is separable. Step 1: for a linearly ordered space, connectedness is equivalent to the conjunction of order-density (between any two degrees lies a third) and Dedekind completeness (every bounded set has a supremum) — a standard equivalence for the order topology. Step 2: separability supplies a countable order-dense subset without endpoints, and Cantor's characterization of the rational order — any two countable, order-dense linear orders without endpoints are order-isomorphic — identifies that subset with the rationals of the open unit interval. Step 3: the Dedekind completion of a fixed dense skeleton is unique, and adjoining the two endpoints of (ii) completes the identification: L is order-isomorphic to [0, 1], and since both sides carry their order topologies, the isomorphism is a homeomorphism. What the theorem does and does not say: it forces the interval given (i)–(iv); it does not forbid richer value-objects — a simplex, an effect algebra, a Hilbert space per distinction — each of which drops the total order of (i) or exceeds the minimality the construction has chosen. Those are different constructions, not counterexamples. The act-theoretic grounds of (i)–(iv) — the two completed sides, the directedness of one movement, the reality of transition under a value-local law with no gaps and no missing limits, and specifiability by countable refinement — are supplied in Remark 1.3″.