

Master Calibration for Non-Overlapping Physical Frameworks: Composition, Closure, and the Limits of Partial Translation

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Abstract

Physics presents itself as convergent, yet systematic inventories of its foundations list dozens of unresolved bifurcations—general relativity versus quantum mechanics, continuum versus discrete description, the Heisenberg cut, the status of the observer. We propose that such schisms are symptoms of frameworks that are each internally self-consistent over disjoint domains, lacking a *master calibration*: a family of partial translation maps between frameworks that calibrates pairs of domains and composes consistently. We formalize the conjecture: frameworks are modeled as calibrated theories over domains; translations are partial maps with quantified error; composition failure is measured by cycle-closure error around loops in the framework graph. We derive closed-form bounds on composed translation error, show that pairwise consistency does not imply global consistency, and give a classification criterion separating structural schisms (no admissible translation within a stated error budget) from conventional ones (translations exist but are costly). Applying the framework to the inventory of 29 bifurcations in the "Hidden Fractures" corpus and to the ultrametric program's claim that seven research domains are vocabularies of one structural object, we compute the pairwise-translation combinatorics (406 pairs among 29 frameworks; 3654 composition constraints; 21 pairs among the seven claimed vocabularies), a worked closure-error budget for a three-framework loop, and a genericity projection showing that beyond roughly seven mutually calibrated frameworks, composition must be enforced by construction rather than hoped for.

1. Introduction

A recurring puzzle in foundational physics is not that any single theory fails on its own terms, but that pairs of successful theories resist unification: general relativity and quantum mechanics, the continuum picture of fields versus discrete spectra, the Heisenberg cut separating quantum description from classical apparatus, and the compositional versus holistic readings of state structure. The working hypothesis of this paper, motivated by the inventory underlying the QNFO corpus [9], is that these bifurcations are not failures of any single framework but symptoms of frameworks that are each internally self-consistent over *disjoint* domains, with no "master calibration" translating between them.

The word *calibration* is borrowed deliberately from metrology and engineering, where it has precise operational meaning: a calibration is a procedure that renders the outputs of one instrument (or model) commensurable with another, with quantified residual error. In sensor engineering, calibration is routinely performed between instruments with *non-overlapping fields of view*—a situation structurally analogous to physics frameworks whose domains of validity do not intersect [3]. In microwave metrology, even the calibration standards themselves can be rechosen without loss of determinability [8]. In machine learning, calibration across multiple domains has been argued to be a special case of invariant representation learning [5], and post-hoc calibration methods have been extended to domain-drift scenarios [7]. In cosmology, calibration precision is identified as a limiting systematic, and unified frameworks have been proposed to reconcile competing calibration classes [6]. These are, we claim, small-scale instances of exactly the problem physics faces at its foundations.

The central objects of study are:

1. **Frameworks** F_i , each a self-consistent theory over a domain D_i .

2. **Partial translation maps** $\tau_{ij} : D_i \supset S_{ij} \rightarrow D_j$, defined only on overlap regions where such overlap exists, with quantified translation error.
3. **Composition conditions**: when does $\tau_{jk} \circ \tau_{ij}$ agree with τ_{ik} on the relevant domain?
4. **Master calibration**: a family $\{\tau_{ij}\}$ that composes consistently for all pairs simultaneously.

Our contributions are: (i) a formal definition of framework, translation, and calibration failure; (ii) explicit counting and error-accumulation results showing that pairwise calibration alone does not guarantee global consistency; (iii) a classification criterion separating structural schisms from conventional ones; and (iv) application to the 29-schism inventory [9] and the ultrametric program's seven-domain claim [11], with all arithmetic shown.

2. Background and Related Work

We organize the related work into three strands: calibration as an engineering discipline under non-commensurability, calibration under domain shift in learning and inference, and the schisms inventory that motivates the master-calibration conjecture.

Calibration with non-overlapping coverage. The problem of calibrating two sensing modalities whose fields of view do not overlap is treated directly in [3], which presents a framework for targetless extrinsic calibration of stereo cameras and LiDAR sensors with a non-overlapping field of view, exploiting road markings as static and robust features among otherwise dynamic objects. This is the closest engineering analogue to our central problem: two instruments, each internally consistent, sharing no common observable, yet requiring a translation (here, an extrinsic transform) to be used jointly. The entry's summary states the framework and the feature choice; it supplies no quantitative results we may cite, so we use it only as a structural precedent for the *mediating domain* move formalized in Section 3. In the same engineering register, [8] proposes a thru-free multiline calibration for vector network analyzers, eliminating the need for a thru (or line) standard by using an arbitrary transmissive two-port device together with an additional reflect standard. This shows that a calibration standard previously thought essential can be replaced by a weaker, more available one while maintaining the internal consistency of the calibration family—which we take as a model for what a "master calibration" might achieve between physical frameworks: replacing an impossible direct standard (a common domain) with an indirect chain of weaker standards, and as evidence that some calibration constraints are conventional rather than structural.

Calibration as a limiting systematic. In 21 cm cosmology, [6] states that calibration precision is currently a limiting systematic, and categorizes most calibration approaches as either "sky-based," relying on an extremely accurate model of astronomical foreground emission, or "redundant," requiring a precisely regular array with near-identical antenna response patterns. The supplied summary is truncated before stating the unification mechanism of the proposed unified framework, so we cite it only for the taxonomy and the claim that calibration is limiting. The structural reading matters for us: two calibration *paradigms* with different assumptions (external foreground model versus internal array regularity) coexist for the same instrument class—a miniature of a physics schism, whose resolution would require a framework containing both.

Calibration under domain shift. In machine learning, [5] draws a link between out-of-domain (OOD) generalization and model calibration, arguing that calibration across multiple domains can be viewed as a special case of an invariant representation; the supplied summary is truncated at this point, so we do not attribute any specific mechanism beyond this link. This supports our thesis at the level of principle: being "calibrated" is not a property of a model alone but a relational property between model and domain, and multi-domain calibration is a stronger, invariant-like condition—the most direct conceptual precedent for our master-calibration notion. Complementarily, [7] addresses uncertainty calibration for domain drift, showing that standard deep neural networks typically yield uncalibrated predictions while post-hoc methods can produce calibrated confidence scores representative of true likelihood, and noting that prior focus has been on in-domain calibration; the summary's second stated contribution is truncated, so we cite only the in-domain

result and the stated intent to move beyond it. The lesson we import: a framework calibrated on its home domain may be uncalibrated under translation, and post-hoc correction is the realistic remedy—analogous to fixing the translation maps between physics frameworks rather than demanding a new monolithic theory.

Community-scale priority setting and shared observables. At the scale of the discipline, [1] describes the European Particle Physics Strategy Update (EPPSU) process as bottom-up: the community is first invited to submit proposals (inputs) for projects to be realised in the near-term, mid-term and longer-term future, with national and laboratory inputs also important elements. We cite this as evidence that the field's self-organization already treats theory choice as an aggregation problem over partially incommensurable community inputs—the sociological shadow of the formal problem we pose; foundational schisms, being cross-cutting rather than facility-specific, fit awkwardly into such a process. Similarly, [2] presents expectations for the design and physics program of an e^+e^- linear collider of center-of-mass energy 500 GeV to 1 TeV and demonstrates its key role in exploring physics beyond the Standard Model over the full range of theoretical possibilities, alongside feasibility of constructing the machine. In our vocabulary, such a facility is a proposed *shared observable*—an attempt to manufacture overlap between frameworks that currently do not overlap; the summary states the energy range and the role claim, and we cite no further specifics. In a different energy regime, [4] analyzes the physical designs of the China Fusion Engineering Test Reactor (CFETR) and the Huazhong Field Reversed Configuration (HFRC), described as the two major projects representative of the low-density steady-state and high-density pulsed pathways to fusion, with physics designs tasked with assessment and analysis; the summary truncates before stating the analysis outcome. This is a concrete instance of two internally coherent programs—two magnetic-confinement pathways—whose joint assessment is the open task, a small-scale analogue of the schism structure we formalize.

The schisms inventory. The QNFO corpus supplies the motivating inventory. [9] ("The Hidden Fractures") reports that physics, often presented as a monolithic, converging body of knowledge, yields on systematic inventory 29 unresolved bifurcations and hidden assumptions—from the nature of the continuum to the status of the observer, the consistency of mathematical language, and the meaning of explanation; the summary truncates mid-sentence, so we cite the count and the examples listed, and frame the response as self-referential calibration. [10] examines a specific claimed resolution: the claim that the central schism of quantum foundations—S10, the observer inside versus outside—is resolved by embedding the observer as a node in an ultrametric tree structure, eliminating the need for an external vantage point; that paper subjects the claim to independent scrutiny, and its summary truncates before the verdict, so we cite only the claim and the scrutiny. This is the right epistemic posture for our purposes: proposed resolutions of schisms must themselves be calibrated. [11] ("The Ultrametric Program") states that seven research domains are claimed to be seven vocabularies for one structural object—nested hierarchical partition logic defined by the ultrametric inequality, with p-adic/adelic arithmetic as one realization and the hierarchy as the invariant—and lists three falsifiable hypotheses (H1 compression prior, H2 Ar..., truncated). The number seven and the claim of one invariant are what we use in Section 4's combinatorics; in our language, the ultrametric program is a candidate master calibration: a single invariant intended to translate across seven domains, and our composition analysis gives a criterion such a candidate must satisfy.

3. Methods

3.1 Frameworks and domains

Definition 3.1 (Framework). A framework is a pair $F_i = (D_i, \mathcal{P}_i)$ where D_i is a domain (a set of states, configurations, or propositions the framework speaks about) and $\mathcal{P}_i$ is a set of primitives—quantities, operations, or axioms the framework treats as given without further calibration. A framework is *internally consistent* if no contradiction is derivable within D_i using $\mathcal{P}_i$; we assume each framework in our motivating set satisfies this, since the schisms arise at the boundaries, not inside.

Examples: non-relativistic quantum mechanics F_{QM} with primitives including the Hilbert-space state $|\psi\rangle$ and unitary evolution $U_t = e^{-iHt/\hbar}$; classical statistical mechanics F_{SM} with primitives including phase-space measure and coarse-graining cells; general relativity F_{GR} with the metric $g_{\mu\nu}$ as primitive.

3.2 Translation maps and error

Definition 3.2 (Translation map). A translation from F_i to F_j is a partial map $\tau_{ij} : S_{ij} \rightarrow D_j$ with $S_{ij} \subseteq D_i$, together with a calibration certificate specifying how primitives of F_i are expressed in primitives of F_j on S_{ij} . The map carries a *translation error* $\varepsilon_{ij} \in [0, 1)$, defined operationally: for a proposition p in the overlap of meaning, $\tau_{ij}(p)$ disagrees with the best available F_j -native rendering of p on a fraction ε_{ij} of a chosen test battery. Symmetry is not assumed: $\varepsilon_{ij} \neq \varepsilon_{ji}$ in general, since calibration is directional (as in the sky-based versus redundant paradigms of [6], which lean on different assumptions).

Two canonical examples, both standard physics rather than novel claims: decoherence supplies a quantum-to-classical translation $\tau_{\text{QM} \rightarrow \text{cl}}$ valid on the sector of states where environment-induced superselection holds; coarse-graining supplies a micro-to-macro translation $\tau_{\mu \rightarrow M}$ valid above a resolution scale ℓ_{cg} .

3.3 Composition and closure

For composable translations τ_{ij} and τ_{jk} , the composed error is bounded by

$$\varepsilon_{ij \circ jk} \leq \varepsilon_{ij} + \varepsilon_{jk} + \varepsilon_{ij} \varepsilon_{jk},$$

a standard first-order composition bound for independent fractional errors, which we adopt as the error structure of the translation semigroupoid. **Definition 3.3 (Composition failure).** Composition *fails* if there exists x in $\tau_{ij}^{-1}(S_{jk}) \cap S_{ik}$ such that $(\tau_{jk} \circ \tau_{ij})(x) \neq \tau_{ik}(x)$. For a cycle $\gamma : F_{i_1} \rightarrow F_{i_2} \rightarrow \dots \rightarrow F_{i_n} \rightarrow F_{i_1}$, the *closure error* is

$$\Delta_\gamma \leq 1 - \prod_{e \in \gamma} (1 - \varepsilon_e),$$

where ε_e are the edge errors. A framework graph is *globally calibrated* to tolerance τ if $\Delta_\gamma \leq \tau$ for all cycles γ .

Definition 3.4 (Master calibration). A family $\mathcal{T} = \{\tau_{ij}\}_{i < j}$ is a master calibration if every square commutes: $\tau_{jk} \circ \tau_{ij} = \tau_{ik}$ on $\tau_{ij}^{-1}(S_{jk}) \cap S_{ik}$.

3.4 Mediating domains

Following the strategy validated in [3]—calibrating two sensors with non-overlapping fields of view through a structure (road markings) visible to both—we define a *mediating domain* M with translations $\tau_{iM} : S_{iM} \rightarrow M$ and $\tau_{Mj} : M \supset \tau_{iM}(S_{iM}) \rightarrow D_j$. The mediated translation is $\tau_{Mj} \circ \tau_{iM}$; it incurs two edge errors instead of one direct error, a price quantified in Section 4.

3.5 Structural versus conventional schisms

Definition 3.5. A schism between F_i and F_j is *structural* at tolerance τ if no admissible translation chain from i to j achieves closure error $\Delta \leq \tau$ (or no nontrivial overlap S_{ij} exists); it is *conventional* if such a chain exists but is costly (long, or requiring strong auxiliary assumptions such as the "extremely accurate foreground model" of [6]). The classification is relative to τ and to available auxiliary structure—which is precisely where engineering ingenuity, as in the thru-free standard of [8], can convert a structural schism into a conventional one. The *master calibration problem* is: given frameworks $\{F_1, \dots, F_n\}$ and candidate translations, does there exist an assignment of edge errors such that all cycles close within τ ? We do not solve this in general; we derive the quantitative machinery and apply it to the corpus counts.

4. Analysis

All inputs below are stated with sources; all arithmetic is shown step by step. No empirical data are used.

Input 1 (from [9]): the number of unresolved bifurcations is $N_{\text{schism}} = 29$.

Input 2 (from [11]): the number of research domains claimed to be vocabularies of one structural object is $n = 7$.

Input 3 (from [2]): the proposed linear collider center-of-mass energy range is $E_{\text{cm}} = 500 \text{ GeV}$ to 1 TeV .

Input 4 (from [6]): calibration precision is a limiting systematic in 21 cm cosmology (qualitative; used to justify nonzero error floors, no number cited).

Derivation 1: counting maps and composition constraints. Treating the 29 bifurcations as 29 frameworks requiring mutual calibration (a modeling choice; calibrating both sides of each dichotomy would give up to $2 \times 29 = 58$ towers, and we carry the conservative $N = 29$), the number of pairwise translation maps for a complete master calibration is

$$\binom{N}{2} = \frac{29 \times 28}{2} = \frac{812}{2} = 406.$$

Each triple $\{i, j, k\}$ yields one independent square constraint $\tau_{jk} \circ \tau_{ij} = \tau_{ik}$:

$$\binom{29}{3} = \frac{29 \times 28 \times 27}{6} = \frac{21924}{6} = 3654.$$

The constraint-to-map ratio is

$$\frac{3654}{406} = 9.0,$$

exactly, since $\binom{N}{3}/\binom{N}{2} = (N-2)/3 = 27/3 = 9$. Interpretation: each new framework added to a calibrated family of size n contributes n new maps but $\binom{n}{2}$ new constraints, so constraints grow quadratically in family size while maps grow linearly. A master calibration is therefore a strongly overdetermined system, and generic assignments of translations will not compose: pairwise consistency does not imply global consistency. Under the factor-2 alternative ($N = 58$): $\binom{58}{2} = 58 \times 57/2 = 1653$ maps and $\binom{58}{3} = 58 \times 57 \times 56/6 = 185136/6 = 30856$ constraints, ratio $56/3 = 18.666 \dots \approx 18.667$; the qualitative conclusion is unchanged.

Derivation 2: pairwise count for the ultrametric program. If each of the $n = 7$ domains requires a translation to each other, the number of unordered pairs is

$$P = \binom{7}{2} = \frac{7 \times 6}{2} = 21,$$

and the directed count is $7 \times 6 = 42$. The single-invariant claim of [11] corresponds to the hypothesis that all 21 pairwise closure errors can be driven below a common τ . Since $29 > 21$, the schism inventory cannot be a subset of the seven-domain pairwise relations alone: at least $29 - 21 = 8$ schisms must involve either frameworks outside the seven-domain set or intra-domain bifurcations (e.g., continuum versus discrete within a single framework's mathematics). This is a genuine constraint derived purely from the two supplied counts, in the most favorable case where every pairwise relation were itself a schism.

Derivation 3: closure-error budget for a three-framework loop. Take a loop $F_1 \rightarrow F_2 \rightarrow F_3 \rightarrow F_1$ with edge errors $\varepsilon_{12} = 10^{-3}$, $\varepsilon_{23} = 2 \times 10^{-3}$, $\varepsilon_{31} = 5 \times 10^{-4}$ (illustrative values, chosen far below unity, consistent with the qualitative claim of [6] that calibration is a limiting but not saturated systematic). The closure bound is

$$\Delta_\gamma \leq 1 - (1 - 10^{-3})(1 - 2 \times 10^{-3})(1 - 5 \times 10^{-4}).$$

Compute each factor: $(1 - 10^{-3}) = 0.999$; $(1 - 2 \times 10^{-3}) = 0.998$; $(1 - 5 \times 10^{-4}) = 0.9995$. Product: $0.999 \times 0.998 = 0.997002$; then $0.997002 \times 0.9995 = 0.997002 - 0.997002 \times 0.0005 = 0.997002 - 0.000498501 = 0.996503499$. Hence

$$\Delta_\gamma \leq 1 - 0.996503499 = 0.003496501 \approx 3.50 \times 10^{-3}.$$

Cross-check by the additive first-order bound: $\varepsilon_{12} + \varepsilon_{23} + \varepsilon_{31} = 10^{-3} + 2 \times 10^{-3} + 5 \times 10^{-4} = 3.5 \times 10^{-3}$, and the exact product bound 3.4965×10^{-3} is indeed below the additive 3.5×10^{-3} , as expected since second-order terms are subtracted; the two agree to within 3.5×10^{-6} in absolute terms.

Derivation 4: tolerance at which a schism becomes structural. Suppose the best available translation chain between two frameworks has $k = 4$ edges, each with error at least $\varepsilon_{\min} = 10^{-2}$ (a floor motivated qualitatively by [6]'s statement that calibration precision is limiting; the floor value itself is an assumption of this illustration, not a measurement). The closure bound is

$$\Delta \leq 1 - (1 - 10^{-2})^4.$$

Compute: $(1 - 10^{-2}) = 0.99$; $0.99^2 = 0.9801$; $0.9801^2 = 0.96059601$; so $\Delta \leq 1 - 0.96059601 = 0.03940399 \approx 3.94 \times 10^{-2}$. Thus with a per-edge floor of 10^{-2} and a 4-edge chain, no calibration finer than $\tau \approx 3.94 \times 10^{-2}$ is achievable; any application demanding $\tau < 3.94 \times 10^{-2}$ classifies the schism as structural under this chain. Equivalently, the maximum chain length tolerable at per-edge error $\varepsilon_{\min}$ and tolerance τ satisfies $1 - (1 - \varepsilon_{\min})^k \leq \tau$, i.e.

$$k \leq \frac{\ln(1 - \tau)}{\ln(1 - \varepsilon_{\min})}.$$

For $\tau = 10^{-2}$ and $\varepsilon_{\min} = 10^{-2}$: $k \leq \ln(0.99)/\ln(0.99) = 1$. At equal floor and tolerance, only single-edge (direct) translations suffice—a formal statement of why "no common domain, no calibration" intuitions arise: long indirect chains are exponentially penalized.

Derivation 5: genericity of commutative squares (projection). Treat each translation direction as independently chosen with probability p of being compatible with a given square constraint, independently across the 3654 constraints of Derivation 1. The probability that all constraints hold is $P_{\text{master}} = p^{3654}$. For $p = 0.9$ (an assumption): $\ln(0.9) = -0.10536$, so $\ln P_{\text{master}} = 3654 \times (-0.10536) = -385.2$, hence $P_{\text{master}} = e^{-385.2} \approx 10^{-167.3}$ (since $-385.2/\ln 10 = -385.2/2.3026 = -167.3$). The largest family size n for which a random master calibration succeeds with probability above 0.01 at $p = 0.9$ requires $\binom{n}{3} \leq \ln(0.01)/\ln(0.9) = (-4.6052)/(-0.10536) = 43.7$, so $\binom{n}{3} \leq 43$; since $\binom{6}{3} = 20$, $\binom{7}{3} = 35$, and $\binom{8}{3} = 56 > 43$, we get $n_{\max} = 7$. As a robustness check, if $p = 0.99$: $\ln P_{\text{master}} = 3654 \times (-0.01005) = -36.72$, giving $P_{\text{master}} \approx 10^{-15.9}$ —still negligible, so the qualitative conclusion is robust to an order of magnitude in $1 - p$. It is notable—and we report it as a numerical coincidence of the model, not a finding about nature—that the ultrametric program of [11] claims exactly seven research domains as vocabularies of one structural object.

Derivation 6: energy-scale window and schism density. From [2], the proposed collider range is $E_{\text{cm}} \in [500 \text{ GeV}, 1 \text{ TeV}]$; converting, $1 \text{ TeV} = 10^3 \text{ GeV}$, so the ratio of upper to lower bound is $10^3/500 = 2$: a single facility covers at most a factor-of-2 window in energy, so any translation requiring phenomena outside this band cannot be calibrated by this shared observable alone—an illustration of why manufactured overlaps are partial, not master, calibrations. Separately, if the $N_{\text{schism}} = 29$ bifurcations of [9] were distributed uniformly over the $n = 7$ domains of [11], the mean would be $29/7 = 4.142857 \dots \approx 4.14$ schisms per domain (uniformity is an assumption for illustration only): each claimed vocabulary carries, on average, more than four open bifurcations.

5. Results

We report only quantities computed in Section 4, plus clearly labeled projections.

R1 (computed). A master calibration over $N = 29$ frameworks requires $\binom{29}{2} = 406$ pairwise translation maps subject to $\binom{29}{3} = 3654$ independent composition constraints—a constraint-to-map ratio of exactly 9.0. Under the factor-2 reading ($N = 58$ towers), the counts are 1653 maps and 30856 constraints, ratio $56/3 = 18.666\dots \approx 18.667$.

R2 (computed). The number of unordered pairwise translations among the $n = 7$ domains claimed as vocabularies of one structural object [11] is $P = 21$ (directed: 42). Since the schism inventory counts $N_{\text{schism}} = 29$ [9] and $29 > 21$, at least $29 - 21 = 8$ schisms lie outside the pairwise relations of the seven-domain set, in the most favorable case for reduction; under the weaker assumption that only some pairs are schismatic, the excess is larger.

R3 (computed). For a three-edge cycle with edge errors $10^{-3}, 2 \times 10^{-3}, 5 \times 10^{-4}$ (illustrative), the closure error is bounded by $\Delta_\gamma \leq 3.4965 \times 10^{-3}$ (exact product form), consistent with the additive bound 3.5×10^{-3} .

R4 (computed, under stated assumptions). With a per-edge error floor of 10^{-2} (assumed, not measured) and a 4-edge chain, the minimum achievable closure error is $\approx 3.94 \times 10^{-2}$; demanding $\tau = 10^{-2}$ restricts admissible chains to $k \leq 1$ edges.

R5 (computed). The collider energy window of [2] spans a factor of 2 (500 GeV to 1 TeV), so it can serve as a shared observable only for translations whose discriminating phenomena fall within that factor-of-2 band.

R6 (computed, under a uniformity assumption). Mean schisms per domain under uniform distribution of 29 over 7: ≈ 4.14 .

Projection P1 (labeled projection). Under the independence model of Derivation 5 with $p = 0.9$ (assumption), the probability that all 3654 squares commute is $P_{\text{master}} = 0.9^{3654} \approx 10^{-167.3}$, and the largest family size for which random composition succeeds with probability ≥ 0.01 is $n_{\text{max}} = 7$; at $p = 0.99$ the probability is $\approx 10^{-15.9}$, still negligible. Uncertainty is dominated by the unknown true p and by correlations among constraints (which the independence assumption ignores); the qualitative conclusion—beyond small families, composition must be enforced by construction—is robust to an order of magnitude in $1 - p$.

Projection P2 (labeled projection). If a master calibration reduced every edge error of the R3 cycle by a common factor $f = 0.5$, the closure bound becomes $1 - (0.9995)(0.999)(0.99975)$; computing: $0.9995 \times 0.999 = 0.9985005$; $0.9985005 \times 0.99975 = 0.9985005 - 0.000249625 = 0.998250875$; so $\Delta \leq 1.749 \times 10^{-3}$, a reduction by a factor of $3.4965/1.749125 \approx 2.0$ —halving edge errors roughly halves closure error at these magnitudes (first-order behavior). This assumes the error model of Section 3.3 and independent edge errors.

6. Discussion

Limitations. First, the identification of $N = 29$ frameworks with the 29 bifurcations of [9] is a modeling choice: bifurcations are dichotomies, and calibrating both sides yields up to 58 towers; we showed the qualitative conclusions are insensitive to this factor, but the counts themselves are not canonical. Second, the error model is deliberately abstract: ε_{ij} is defined relative to a "test battery" of propositions whose selection is itself a convention—a reflexive weakness, since the consistency of mathematical language is one of the 29 schisms [9]. The composition bound assumes edge errors combine as independent fractional disagreements; correlated errors (a shared flawed assumption in two frameworks) would violate independence and could make closure worse than the bound suggests. For frameworks as different as general relativity and quantum mechanics, no shared test battery of propositions is currently agreed upon, so even the translation error ε_{ij} of a proposed direct map cannot today be measured; this is the practical content of classifying such a schism as structural at any nontrivial tolerance τ . Third, the genericity projection of Derivation 5 rests

on an independence assumption over composition constraints whose true correlation structure is unknown; the computed probabilities $P_{\text{master}} \approx 10^{-167.3}$ (at $p = 0.9$) and $\approx 10^{-15.9}$ (at $p = 0.99$) are therefore illustrative of the overdetermination, not predictions. What would falsify the framework: a demonstration that a large family of frameworks (say $n \geq 10$) admits translations whose squares commute to a stated tolerance without enforcement, or an explicit construction showing the composition bound of Section 3.3 is loose by orders of magnitude for physically motivated translations. Open questions include whether the ultrametric program's seven-domain claim [11] can be recast as an explicit master calibration passing the closure criterion, and whether the excess of at least $29 - 21 = 8$ schisms over the seven-domain pairwise count reflects frameworks outside that set or intra-domain bifurcations.

7. Conclusion

We have proposed the master-calibration conjecture: foundational schisms in physics are symptoms of internally self-consistent frameworks over disjoint domains that lack a family of partial translation maps composing consistently. We formalized frameworks, partial translations with quantified error, composition and cycle-closure bounds, and a structural-versus-conventional classification of schisms relative to a tolerance τ . Applying the machinery to the supplied corpus counts, we computed: $\binom{29}{2} = 406$ pairwise maps and $\binom{29}{3} = 3654$ composition constraints for the 29-bifurcation inventory of [9], a constraint-to-map ratio of exactly 9.0; $\binom{7}{2} = 21$ pairwise relations for the seven-domain ultrametric claim of [11], leaving at least $29 - 21 = 8$ schisms outside any pairwise reduction; a worked three-edge closure budget of $\Delta_\gamma \leq 3.4965 \times 10^{-3}$; and, as a labeled projection under an independence model, that random composition of 3654 squares succeeds with probability $\approx 10^{-167.3}$ at $p = 0.9$, with the largest self-calibrating family size $n_{\text{max}} = 7$. The upshot is that beyond small families, global consistency must be enforced by construction rather than hoped for; a candidate master calibration such as the ultrametric program must therefore be checked against the closure criterion, not merely asserted. The framework's own test battery is conventional, and the counts are modeling choices; both weaknesses are stated so that the conjecture can be falsified by the criteria of Section 6.

References

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