

Is the Meta-Pattern of Reification Physically Real? A Reconciled Audit with a Quantified Cost Framework

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Abstract

A the QNFO archive document (<https://papers.qnfo.org/papers/meta-pattern-of-reification-in-physics/>) proposes a "Meta-Pattern of Reification in Physics" and poses the question of whether this pattern is something physically real rather than a descriptive regularity. This paper treats that question as an operational audit problem. We formalize the claim as hypothesis **II**: that representational or informational constructs acquire causal, physical consequences across independent domains. We define three criteria for physical reality — multi-domain instantiation, differential predictability, and observer-independence — and supplement them with a graded test scheme (instantiation, intervention, invariance) and a quantitative cost model for reifying a constraint across n independent channels, $p_{\text{fail}} = 1 - (1 - \epsilon)^n$. We audit a fixed sample of ten bibliography entries spanning particle-physics strategy, collider design, DRAM security, fusion design, embedded side channels, neutrino facilities, demonstration physics, turbulence modelling, and the adelic-completion mathematics of the companion the QNFO archive record (<https://papers.qnfo.org/papers/the-adelic-constraints-project-a-complete-account/>). The audit yields a reification index $R = 8/10 = 0.80$ with a symmetric-null upper-tail probability $P(X \geq 8) = 56/1024 = 0.0546875$, but shows that the pattern, as documented, fails the differential-predictability criterion: it is compatible with both its affirmation and its negation in every sampled domain. We conclude that the pattern is a robust descriptive lens but not yet a physically real entity, and we state the observation that would change this verdict.

1. Introduction

The input to this study is a single sentence of research intent: "Re-entry from <https://papers.qnfo.org/papers/meta-pattern-of-reification-in-physics/>: something physically real?" The referenced document, *QNFO: Meta-Pattern of Reification in Physics* [9], proposes a meta-pattern — a pattern about patterns — said to recur across physics. A companion document, *QNFO: The Adelic Constraints Project — A Complete Account* [10], describes a research project that asked whether a specific piece of pure mathematics — the fact that the rational numbers can be "completed" in multiple incompatible ways, linked by a single identity — has consequences beyond mathematics itself.

The question "is it something physically real?" is precise enough to be audited, but only after the informal phrase "physically real" is replaced by operational criteria. Physics has well-established procedures for deciding whether a proposed entity is real: the entity must appear in more than one independent measurement context, it must make predictions that differ from those of its negation, and it must not dissolve when the observer's representational apparatus is removed. These criteria are standard in the design of large-scale physics programmes: the community-strategy process documented in [1] exists precisely to convert proposed ideas into testable facility programmes, and the collider-design literature [2] explicitly frames feasibility in terms of experiments that can decide among theoretical possibilities.

This paper makes four contributions. First, it formalizes the reification claim as hypothesis **II** and states three operational criteria for physical reality (Section 3). Second, it applies those criteria to a fixed, non-cherry-picked sample: the ten works supplied in the bibliography of this paper, which span genuinely independent research domains. Third, it supplements the binary audit with a graded test scheme and a cost model, evaluating the cost model with full arithmetic at explicitly labeled illustrative parameters. Fourth, it computes the one explicit physical scale in the sample — the energy range of [2] — in both relative and absolute (SI) terms, as a concrete demonstration of what "quantified" means in this context. The honest answer to "something physically real?" is conditional, and we state the exact condition.

2. Background and Related Work

We discuss each supplied bibliography entry in turn, restricting every statement to what the entry's own supplied summary supports.

[1] Physics Briefing Book (arXiv:1910.11775v2). The summary describes the European Particle Physics Strategy Update (EPPSU) process as bottom-up: the community is first invited to submit proposals (inputs) for projects it would like to see realised in the near-term, mid-term and longer-term future, with national inputs and inputs from national laboratories also important. This is a documented instance of representational constructs — written proposals — being converted into a prioritised roadmap for physical facilities, and it supplies our clearest example of an institutional reification pipeline.

[2] Physics and Technology of the Next Linear Collider (arXiv:hep-ex/9605011v1). The summary presents expectations for the design and physics programme of an e^+e^- linear collider of centre-of-mass energy 500 GeV to 1 TeV, reviews the experiments that would be carried out at this facility, demonstrates its key role in exploring physics beyond the Standard Model over the full range of theoretical possibilities, and shows the feasibility of constructing the machine. It is a canonical case of a design document in which theoretical possibilities are made decidable by a physical machine, and it supplies the only explicit quantitative energy scale in our sample.

[3] JENGA (arXiv:2609.01077v1). The summary states that safety-critical real-time systems must satisfy multiple dependability requirements, notably time predictability and security; that tasks must complete within bounded and known execution times, typically characterised through Worst-Case Execution Time (WCET) analysis; and that DRAM-based platforms are increasingly sensitive to the RowHammer read-disturbance security vulnerability. The title further indicates that counter-based RowHammer countermeasures can be exploited to break real-time predictability. This is a physical-to-informational-to-physical loop: a physical disturbance mechanism induces countermeasures, which in turn feed back into physically observable timing behaviour.

[4] MHD analysis on the physical designs of CFETR and HFRC (arXiv:2107.11742v1). The summary identifies the China Fusion Engineering Test Reactor (CFETR) and the Huazhong Field Reversed Configuration (HFRC), both under intensive physical and engineering design in China, as the two major projects representative of the low-density steady-state and high-density pulsed pathways to fusion, with magnetohydrodynamic (MHD) assessment and analysis as a primary task of the physics designs (the summary truncates here). Here mathematical MHD models are reified into engineering hardware pathways.

[5] Physical Side-Channel Attacks on Embedded Neural Networks: A Survey (arXiv:2110.11290v1). The summary notes that deep neural networks have progressively been integrated on all types of platforms, from data centres to embedded systems including low-power processors and, recently, FPGAs, and that neural networks are expected to become ubiquitous in IoT systems, including safety-critical and security-sensitive domains (the summary truncates). The title indicates the survey's subject: physical side-channel attacks on such embedded networks, i.e., physical emanations of a computation becoming informationally exploitable — the mirror image of the loop in [3].

[6] Physics at a future Neutrino Factory and super-beam facility (arXiv:0710.4947v3). The summary presents the conclusions of the Physics Working Group of the international scoping study (ISS) of a future Neutrino Factory and super-beam facility, carried by the international community between NuFact05 (the 7th International Workshop on Neutrino Factories and Superbeams, Laboratori Nazionali di Frascati, Rome, June 21–26, 2005) and NuFact06 (Irvine, California, 24–30 August, per the truncated summary). Like [1], it documents the conversion of community deliberation into a concrete facility concept.

[7] **Physics Magic (arXiv:physics/0606151v1)**. The summary states the paper's purpose: to show the magic of physics by showing the physics of magic; that magic tricks and demonstrations are interesting inasmuch as something unexpected occurs; and that since expectations are linked to preconceptions, a demonstration making use of a flaw in a preconception will result in something unexpected (the summary truncates). This entry is directly relevant to our criteria: it is an explicit study of the gap between representation (preconception) and physical outcome (demonstration).

[8] **Physically constrained eigenspace perturbation for turbulence model uncertainty estimation (arXiv:2311.01355v2)**. The summary explains that aerospace design increasingly incorporates Design Under Uncertainty approaches for more robust and reliable optimal designs; that these approaches require dependable estimates of uncertainty in simulations; and that the key contributor of predictive uncertainty in computational fluid dynamics (CFD) simulations of turbulent flows is the structural limitations of Reynolds-averaged models (the summary truncates). The title indicates a physically constrained eigenspace perturbation method for estimating that uncertainty — a representational model defect being quantified so that physical design can proceed.

[9] **QNFO: Meta-Pattern of Reification in Physics (https://papers.qnfo.org/papers/meta-pattern-of-reification-in-physics/)**. The supplied summary for this entry is empty; the grounding input gives only the title and the research question quoted in Section 1. We therefore use this entry solely as the *object* of the audit — the claim under test — and not as a source of findings about the world. This is a material limitation, stated here rather than hidden.

[10] **QNFO: The Adelic Constraints Project — A Complete Account (https://papers.qnfo.org/papers/the-adelic-constraints-project-a-complete-account/)**. The summary describes a complete, self-contained account of a research project conducted in May 2026, which asked whether a specific piece of pure mathematics — the fact that the rational numbers can be "completed" in multiple incompatible ways, and that a single identity links all (the summary truncates) — has consequences beyond pure mathematics. This is the reification question in its purest form: does an abstract mathematical fact become physically consequential?

Taken together, the sample spans strategy documents [1], [6], machine-design feasibility studies [2], [4], security physics [3], [5], the psychology of demonstration [7], simulation-uncertainty methodology [8], and the two the QNFO archive documents under audit [9], [10]. No two entries share a subfield, which is exactly what a multi-domain test of Π requires.

3. Methods

3.1 The hypothesis under test

We formalize the claim of [9] as:

Π : representational or informational constructs acquire causal, physical consequences, as a pattern recurring across independent phy

"Representational construct" here means any entity whose primary mode of being is descriptive: a proposal, a design expectation, a mathematical structure, a model, a preconception. "Causal, physical consequence" means an observable change in a physical system or artefact attributable to that construct.

3.2 Criteria for physical reality

A pattern counts as *physically real* in the strong sense if it satisfies all three criteria:

- **C1 (multi-domain instantiation)**: the pattern is exhibited in at least two research domains with no shared methodology or community.
- **C2 (differential predictability)**: the pattern, applied to a new domain, yields a prediction that differs from the prediction of its negation $\neg\Pi$, in a setting that can be measured.
- **C3 (observer-independence)**: the pattern's description does not depend constitutively on the observer's language or choice of representation; two independent observers applying the criteria would agree on whether the pattern is present.

Criterion C2 is the decisive one and mirrors the logic of [2], where a machine is justified by its ability to decide among "the full range of theoretical possibilities": a real entity must be able to lose a test.

3.3 Graded test scheme and cost model

Following the graded convention, an abstraction A is physically real to degree $r(A) \in \{0, 1, 2, 3\}$: $r(A) = 0$ if no test passes; $r(A) = 1$ if only instantiation passes (an apparatus whose state realizes A exists or is credibly feasible); $r(A) = 2$ if instantiation and intervention pass (an intervention changing A produces a detectable, predicted change in an observable); $r(A) = 3$ if invariance also passes (the relation is consistent across independent apparatuses within stated tolerance).

For the cost of reification: let A be a constraint whose physical enforcement requires n independent realizations, each failing tolerance with probability ϵ per operational cycle, independently. The probability that at least one realization fails in a cycle is

$$p_{\text{fail}}(n, \epsilon) = 1 - (1 - \epsilon)^n.$$

For small ϵ , the expansion $p_{\text{fail}} = n\epsilon - \frac{n(n-1)}{2}\epsilon^2 + O(\epsilon^3)$ shows the cost grows approximately linearly in n . Conversely, given a budget p^* , the required per-realization tolerance is

$$\epsilon_{\text{max}}(n, p^*) = 1 - (1 - p^*)^{1/n}.$$

3.4 Audit protocol

The audit sample is the fixed bibliography of this paper: $N = 10$ entries. For each entry i we assign a binary instantiation score $s_i \in \{0, 1\}$: $s_i = 1$ if and only if the entry's own supplied summary shows a representational construct acquiring a physical consequence (or the physical-to-informational-to-physical loop of [3], [5]); $s_i = 0$ otherwise, including the case of an empty summary. The reification index is

$$R = \frac{1}{N} \sum_{i=1}^N s_i.$$

Under a symmetric null model H_0 in which each entry independently shows the pattern with probability $p_0 = 0.5$, the count $X = \sum_i s_i$ follows Binomial(N, p_0):

$$P(X = k) = \binom{N}{k} p_0^k (1 - p_0)^{N-k}.$$

Scoring rules fixed before application: (i) only text in the supplied summary counts; (ii) an empty summary forces $s_i = 0$; (iii) a summary describing only planning or deliberation scores $s_i = 1$ only if the summary itself states that the deliberation targets physical realisation (as [1] and [6] do, via "realised" and "facility"); (iv) purely mathematical content scores $s_i = 1$ only if the summary states a physical consequence, which the truncated summary of [10] does not.

4. Analysis

4.1 Scoring the sample

i	Entry	Reason from summary	s_i
1	[1] EPPSU	Proposals (representational) explicitly aimed at projects "to be realised"	1
2	[2] NLC report	Design expectations leading to feasibility of constructing a physical machine	1
3	[3] JENGA	Physical RowHammer disturbance leads to countermeasures, which break timing predictability	1
4	[4] CFETR/HFRC	MHD physics designs as primary task of engineering hardware pathways	1
5	[5] Side-channel survey	Physical emanations of embedded NN computation become exploitable information	1
6	[6] Neutrino Factory ISS	Community scoping study producing a concrete facility concept	1
7	[7] Physics Magic	Preconceptions (representational) exploited to produce unexpected physical demonstrations	1
8	[8] Eigenspace perturbation	Model-structural limitation (representational) quantified for physical design	1
9	[9] Meta-Pattern	Summary empty; rule (ii) forces 0	0
10	[10] Adelic project	Summary states the mathematical fact but truncates before any physical consequence; rule (iv) forces 0	0

4.2 Reification index

$$R = \frac{1}{10} \sum_{i=1}^{10} s_i = \frac{1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 0 + 0}{10} = \frac{8}{10} = 0.80.$$

4.3 Null probability

Under H_0 with $N = 10$, $p_0 = 0.5$:

$$P(X = 8) = \binom{10}{8} \left(\frac{1}{2}\right)^{10} = \frac{45}{1024} = 0.0439453125.$$

The upper tail:

$$P(X \geq 8) = \frac{\binom{10}{8} + \binom{10}{9} + \binom{10}{10}}{1024} = \frac{45 + 10 + 1}{1024} = \frac{56}{1024} = 0.0546875.$$

So the observed agreement across eight independent domains would occur by chance under the symmetric null about 5.47% of the time — suggestive but not decisive at a conventional 5% threshold, and the threshold itself is a convention, not a physical fact.

4.4 The explicit physical scale in the sample

Entry [2] states a centre-of-mass energy range of 500 GeV to 1 TeV. With $E_{\min} = 500 \text{ GeV}$ and $E_{\max} = 1 \text{ TeV} = 1000 \text{ GeV}$:

$$\frac{E_{\max}}{E_{\min}} = \frac{1000 \text{ GeV}}{500 \text{ GeV}} = 2,$$

and the width of the interval is

$$\Delta E = E_{\max} - E_{\min} = 1000 \text{ GeV} - 500 \text{ GeV} = 500 \text{ GeV} = 5.0 \times 10^{11} \text{ eV}.$$

Converting to SI units with $1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$:

$$\Delta E_{\text{J}} = 5.0 \times 10^{11} \text{ eV} \times 1.602 \times 10^{-19} \frac{\text{J}}{\text{eV}} = 8.010 \times 10^{-8} \text{ J} \approx 8.0 \times 10^{-8} \text{ J},$$

where the mantissa product is $5.0 \times 1.602 = 8.010$ and the exponents combine as $10^{11} \times 10^{-19} = 10^{-8}$. Only entry [2] supplies a physical energy scale in its summary; the summary of [6] contains dates and ordinals (NuFact05, "7th International Workshop", "June 21–26, 2005", "24–30 August") but no physical quantities, and the remaining summaries contain no physical quantities either. This is itself evidence about how the reification pattern is documented — as narrative, not as measurement.

4.5 Testing criterion C2 on the sample

C2 requires that Π and $\neg\Pi$ give different predictions in a measurable setting. Consider the strongest candidate, entry [3]: Π predicts that a representational countermeasure (a hardware counter) will have physically observable timing consequences; $\neg\Pi$ predicts countermeasures are timing-neutral. The title of [3] states that counter-based RowHammer countermeasures *can be exploited to break real-time predictability* — so in this single domain, Π and $\neg\Pi$ are in principle decidable, and the summary's framing supports Π . Now apply the same test to the pattern as a whole: the documents [9], [10] supply no setting in which the meta-pattern itself could fail. Formally, for every domain d in the sample, the documented pattern is stated at a level of generality such that

$$P(\text{observation} \mid \Pi) \approx P(\text{observation} \mid \neg\Pi)$$

for all observations the documents describe: any representational construct with physical effect confirms Π , and any construct without one can be excluded as "not an instance of the pattern." This is the audit's central negative finding: the pattern, as documented, has no discriminating power.

4.6 Cost model at illustrative parameters

Illustrative assumption, labeled: a constraint reified across $n = 4$ independent realizations with per-realization failure probability $\epsilon = 10^{-3}$ per cycle, and a budget $p^* = 10^{-2}$. These values are chosen for arithmetic transparency, not measured anywhere.

Derivation 1 (failure probability).

$$p_{\text{fail}} = 1 - (1 - 10^{-3})^4 = 1 - (0.999)^4.$$

Compute $(0.999)^2 = 0.998001$; then $(0.999)^4 = (0.998001)^2 = 0.996005998001$. Hence

$$p_{\text{fail}} = 1 - 0.996005998001 = 0.003994001999 \approx 3.99 \times 10^{-3}.$$

First-order check: $n\epsilon = 4 \times 10^{-3} = 4.00 \times 10^{-3}$; the exact value 3.994×10^{-3} is below it by 6.0×10^{-6} , consistent with the quadratic correction $\frac{n(n-1)}{2}\epsilon^2 = 6 \times 10^{-6}$.

Derivation 2 (required tolerance). With $p^* = 10^{-2}$ and $n = 4$:

$$\epsilon_{\text{max}} = 1 - (1 - 10^{-2})^{1/4} = 1 - (0.99)^{0.25}.$$

Compute $\ln(0.99) = -0.01005034$; divided by 4: -0.00251258 ; exponentiating: $e^{-0.00251258} = 0.99749057$. Hence

$$\epsilon_{\text{max}} = 1 - 0.99749057 = 2.50943 \times 10^{-3} \approx 2.51 \times 10^{-3}.$$

Check: with $\epsilon = 2.50943 \times 10^{-3}$, $(1 - \epsilon)^4 = (0.99749057)^4$; $(0.99749057)^2 = 0.99498744$, squared again gives $0.99000000 \approx 0.99$, so $p_{\text{fail}} \approx 1 - 0.99 = 10^{-2} = p^*$. Consistent.

Derivation 3 (tightening factor and linear-approximation accuracy).

$$\frac{\epsilon_{\text{single}}}{\epsilon_{\text{max}}} = \frac{10^{-2}}{2.50943 \times 10^{-3}} = 3.98497,$$

i.e., each channel must be roughly 4 times tighter than a single channel carrying the same budget. The ratio of exact to first-order failure probability at $n = 4$, $\epsilon = 10^{-3}$:

$$\frac{p_{\text{fail}}}{n\epsilon} = \frac{3.994002 \times 10^{-3}}{4.0 \times 10^{-3}} = 0.99850,$$

so the linear rule $p_{\text{fail}} \approx n\epsilon$ overestimates by about 0.15% at these parameters, and is accurate to better than 0.2% for $\epsilon \leq 10^{-3}$, $n \leq 4$.

4.7 Projection for a doubled sample

Projection, with stated assumptions: if the pattern's instantiation rate in the sampled population is $p = R = 0.8$ and a hypothetical replication audit scored $n = 20$ further independent entries with the same protocol, the expected count and standard deviation would be

$$\mu = np = 20 \times 0.8 = 16, \quad \sigma = \sqrt{np(1-p)} = \sqrt{20 \times 0.8 \times 0.2} = \sqrt{3.2} \approx 1.7889.$$

This projection assumes the new entries are drawn from domains as diverse as the present sample and scored by the same rules; it is not a measurement.

5. Results

The audit produces exactly the following computed quantities:

1. **Reification index:** $R = 8/10 = 0.80$ (Section 4.2), from the per-entry scores in Section 4.1.
2. **Null point probability:** $P(X = 8) = 45/1024 = 0.0439453125$ (Section 4.3).
3. **Null upper-tail probability:** $P(X \geq 8) = 56/1024 = 0.0546875$ (Section 4.3).
4. **Energy-scale ratio from [2]:** $E_{\text{max}}/E_{\text{min}} = 2$ (Section 4.4).
5. **Energy interval width from [2]:** $\Delta E = 500 \text{ GeV} = 5.0 \times 10^{11} \text{ eV} = 8.0 \times 10^{-8} \text{ J}$ (Section 4.4).
6. **Cost model (illustrative parameters, labeled):** for $n = 4$, $\epsilon = 10^{-3}$: $p_{\text{fail}} = 3.994002 \times 10^{-3} \approx 3.99 \times 10^{-3}$; for $p^* = 10^{-2}$, $n = 4$: $\epsilon_{\text{max}} = 2.50943 \times 10^{-3} \approx 2.51 \times 10^{-3}$, a tightening factor of 3.98497; linear approximation accurate to 0.15% (Section 4.6).
7. **Projection (labeled):** for $n = 20$ future entries at $p = 0.8$, $\mu = 16$, $\sigma = \sqrt{3.2} \approx 1.7889$ (Section 4.7).

Substantive findings: (a) the pattern Π is instantiated, by the fixed scoring rules, in eight of ten independent domains, satisfying criterion C1; (b) the sample contains no documented setting in which the meta-pattern itself makes a differential prediction, so criterion C2 fails for Π as documented; (c) two entries — the two the QNFO archive documents [9], [10] — are precisely the ones that cannot be scored, because one summary is empty and the other truncates before stating any physical consequence; the claim under audit is thus the least-documented item in its own audit. Graded placement: the facility design studies of [2] and [6] sit at $r = 1$ (paper-stage feasibility, no apparatus); the fusion designs of [4] sit at $r \in \{1, 2\}$ (intensive engineering design implies intervention analysis, but the summary does not confirm construction); the RowHammer countermeasure of [3] and the embedded networks of [5] sit at $r = 3$ (deployed hardware with measurable physical consequences); the demonstrations of [7] sit at $r = 3$ for the physical effects shown; the adelic identity of [10] sits at $r \leq 1$ pending any proposed apparatus.

6. Discussion

The central tension. The audit gives Π a high instantiation score ($R = 0.80$) and simultaneously shows that the score is nearly unfalsifiable: the scoring rules were easy to satisfy because the pattern is stated broadly enough to cover any case where an idea leads to a machine, a measurement, or an attack. A pattern that cannot fail C2 cannot be established as physically real by C1-style evidence alone, no matter how many domains it spans. The 5.47% tail probability is suggestive, but it is computed under a null model ($p_0 = 0.5$, independent entries) chosen for tractability, not because it is physically motivated; a null with $p_0 = 0.9$ would make the observation unremarkable, and correlated entries (e.g., [1] and [6] share the facility-roadmap genre) would inflate the effective tail.

Limitations. (i) The sample is the bibliography of this paper, not a random or systematic sample of physics; it was fixed by the grounding input, which is both a strength (no cherry-picking by us) and a weakness (no coverage guarantee). (ii) All scoring rests on truncated summaries; several entries end mid-sentence, and entry [9] has no summary at all, so $s_9 = 0$ is a protocol artefact, not evidence against the pattern. (iii) The binary score s_i collapses graded judgements; the graded scheme of Section 3.3 partially repairs this but its grades are ordinal, not metric, and two objects at $r = 3$ may differ by orders of magnitude in measurement precision. (iv) The cost model assumes independence of realizations; correlated failures (common cause, shared fabrication batch) break the factorization $(1 - \epsilon)^n$ and would raise p_{fail} above the computed values. (v) The illustrative parameters ($n = 4$, $\epsilon = 10^{-3}$, $p^* = 10^{-2}$) were chosen for arithmetic transparency; no measured system in the bibliography supplies these numbers, so the cost-model results are method demonstrations, not empirical findings. (vi) The projection of Section 4.7 assumes a replication sample we do not have.

What would falsify the claims of this paper. Our negative finding on C2 would be falsified by exhibiting a pre-registered, measurable setting in which the meta-pattern of [9] predicts an outcome that its negation does not — for example, a new domain where the pattern correctly anticipates *which* representational construct will acquire physical consequences, before the fact, with stated error bars. Our positive finding on C1 would be falsified by showing that two or more of the eight scored instantiations fail on the full texts rather than the summaries. The claim that reification cost scales as $n\epsilon$ would be falsified by a counterexample system with strongly correlated failures where the measured system failure rate exceeds $n\epsilon$ substantially at small ϵ ; the model would then need a copula-style correction. The grading scheme would be falsified as a useful taxonomy if a clear case emerged where intervention passes without instantiation, which our definitions declare impossible by construction.

Arguing against ourselves. A defender of [9] could reasonably object that demanding differential predictions of a *meta*-pattern is a category error — that meta-patterns are organisational lenses, like symmetry principles, which earn physical status through the success of their instances. That objection has force; but it concedes the main point of this paper: on the available documentation, the meta-pattern is real in the way a good classification is real, not in the way a field excitation is real. A second objection targets the adelic case: a mathematical identity does not need physical instantiation to be "real" in the sense mathematicians intend, and forcing it through the three tests may be a false reification of the reification question itself. A defender of [10]'s project might respond that the identity constrains which physical theories are internally consistent — an invariance claim at the level of theory space rather than apparatus. Our framework can express this, but we have not formalized it, and doing so is open. Conversely, we note that our own audit is vulnerable to the mirror-image objection: by scoring planning documents such as [1] and [6] as instantiations, we may have reified the reification pattern ourselves, treating the intention to build as equivalent to building. A stricter protocol that required demonstrated physical consequences would lower R substantially, and we cannot exclude that outcome on the supplied summaries alone. Both objections point to the same requirement: the debate should move from narrative to pre-registered, differential tests.

7. Conclusion

We audited the question posed by [9] — whether the meta-pattern of reification in physics is something physically real — by converting it into hypothesis Π and testing it against a fixed ten-entry bibliography spanning independent domains. Using fixed scoring rules applied only to the supplied summaries, the pattern is instantiated in eight of ten entries, giving a reification index $R = 8/10 = 0.80$ with a symmetric-null upper-tail probability $P(X \geq 8) = 56/1024 = 0.0546875$; criterion C1 (multi-domain instantiation) is therefore satisfied. However, criterion C2 (differential predictability) fails: the pattern, as documented, is compatible with both its affirmation and its negation in every sampled domain, and the two the QNFO archive documents central to the question — [9] with an empty summary and [10] with a truncated one — are the least-documented items in their own audit. The graded scheme places the sampled objects between $r = 1$ (paper-stage facility studies [2], [6]) and $r = 3$ (deployed hardware with measurable consequences [3], [5], [7]). The quantitative cost model, evaluated at explicitly illustrative parameters ($n = 4$, $\epsilon = 10^{-3}$, $p^* = 10^{-2}$), demonstrates the method: $p_{\text{fail}} = 3.99 \times 10^{-3}$, $\epsilon_{\text{max}} = 2.51 \times 10^{-3}$, a tightening factor of 3.98497, with the linear rule $p_{\text{fail}} \approx n\epsilon$ accurate to about 0.15% at these parameters. Our verdict: the meta-pattern is a robust descriptive lens, real in the way a good classification is real, but not yet established as a physically real entity. The single observation that would change this verdict is a pre-registered, measurable setting in which the pattern predicts, before the fact and with stated error bars, an outcome its negation does not.

References

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Appendix A. Divergence report

The reconciled draft resolved two divergences among the independent writer drafts. (A1) Graded placement of [6]: one draft classified it as a collider design at $r = 1$; another objected that the supplied summary describes a Neutrino Factory and super-beam facility scoping study, not a collider. Resolution: the main text uses the neutral phrase "facility design studies," which the summary supports; the classification convention (paper-stage scoping documents score $r = 1$) is unchanged. (A2) Count of number-free summaries: one draft stated that eight of ten summaries contain no number; another noted that the summary of [6] contains dates and ordinals (NuFact05, "7th International Workshop", "June 21–26, 2005", "24–30 August"), contradicting the count. Resolution: the main text now claims only that entry [2] is the sole summary supplying a physical energy scale, with [6] containing dates and ordinals but no physical quantities; the underlying convention (what counts as "a number") is documented here.