

Measurement as Place-Crossing: Completion-Selective Adelic Projection

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Abstract

We propose a structural reframing of the quantum measurement problem in number-theoretic terms. By Ostrowski's theorem, the completions of $\mathbb{Q}$ consist of a single Archimedean place ($\mathbb{R}$) and countably many p -adic places ($\mathbb{Q}_p$); standard quantum mechanics is formulated exclusively over the Archimedean completion. We conjecture that a quantum state admits a coherent adelic extension across all places, and that measurement is a *place-crossing event*: coupling to a place-specific apparatus acts as a completion-selective projection that suppresses amplitudes on non-selected completions. We formalize this program in three steps: (i) a Hilbert space over the adeles with local factors H_v at each place v and a product-formula coherence condition; (ii) a place-selective coupling operator whose Lindblad-type master equation yields exponential suppression of inter-place coherence at rate $\Gamma_{vw} = \frac{1}{2}(\Gamma_v + \Gamma_w)$ with $\Gamma_v = \lambda_v^2 N_b \sigma_A^2$; (iii) a worked two-place (real/3-adic) model in which we derive, with full arithmetic, the suppression timescale $T_\times = 16$ model units, the rate ratio $\Gamma_\infty/\Gamma_3 = 4$, Born-rule recovery with residual deviation 3.3009×10^{-3} after five coherence times, and a consistency bound $t \geq 58.41$ model units against the 1.3×10^{-2} readout-error floor of state-of-the-art superconducting platforms. All quantitative results are analytic derivations within the proposed model; no empirical claims are made. We discuss falsifiability, the relation to adelic path integrals and equidistribution theory, and the framework's central open assumption: the place-prior that selects the Archimedean completion.

1. Introduction

The measurement problem — why a superposition yields a single definite outcome — has resisted purely dynamical resolution for a century. Existing approaches modify dynamics (objective collapse), reinterpret the state (Everett), or reaxiomize measurement statistics [3], [5]. None of these asks a question we take to be foundational: *why is the Hilbert space of physics Archimedean?* Ostrowski's theorem states that the only non-trivial absolute values on $\mathbb{Q}$, up to equivalence, are the usual real absolute value $|\cdot|_\infty$ and the p -adic absolute values $|\cdot|_p$ for primes p [9], [10]. Each absolute value completes $\mathbb{Q}$ to a distinct field: $\mathbb{R}$ at the infinite place $v = \infty$, and $\mathbb{Q}_p$ at each finite place $v = p$. These completions are mutually singular as topological and measure spaces [9], [10]. Standard quantum mechanics builds its Hilbert spaces over $\mathbb{R}$ or $\mathbb{C}$, i.e., over a single place.

The QNFO program [9], [10], [11] argues that this exclusive Archimedean commitment is a contingent, historically accumulated choice — a "measure-theoretic artifact" — and that Tate's thesis [11] supplies a template in which local factors at every place are treated uniformly and combined into a global adelic object. Dragovich's adelic path-integral program realizes this for free theories: the propagator factors as a product of local propagators, one Archimedean and the rest p -adic, whose product is adelic-invariant. If physical states are adelic, then the measurement problem acquires a new degree of freedom: *which completion does the apparatus inhabit?*

Our central conjecture is:

Conjecture (Place-Crossing Measurement). A closed quantum system evolves coherently across all completions of $\mathbb{Q}$. Measurement is the event in which coupling to an apparatus that exists at a specific place v_0 projects the joint state onto the v_0 -completion, suppressing amplitudes at all other places.

This reframing has three attractions. First, it is *structural*: collapse is not an added stochastic process but a consequence of the local-global architecture of number theory, analogous to how adelic products enforce local-global consistency in the arithmetic equidistribution theorems of Baker–Rumely, Favre–Rivera–Letelier, and Chambert-Loir [1]. Second, it is *selective*: the apparatus, being a macroscopic Archimedean object (built of real-valued positions, energies, clock readings), naturally selects $v = \infty$; a hypothetical p -adic apparatus would select $v = p$. Third, it makes contact with the Langlands program as physics [11], since place-crossing is the operative notion in automorphic constructions.

We emphasize scope at the outset: everything quantitative in this paper is an analytic derivation *within the proposed model*, not an empirical measurement or a first-principles consequence of standard quantum mechanics. The model's physical status is conjectural; Section 6 states what would falsify it.

2. Background and Related Work

Adelic and arithmetic structures. Ostrowski's theorem and the mutual singularity of completions are catalogued in the QNFO taxonomy [9], [10], which documents "completion failures" arising when Archimedean measure-theoretic intuitions are exported without justification, and frames the "completion problem" as a foundational question for physics. The structural template for adelic quantum mechanics — local factors at each place, a global restricted product, and the interpretation of the Langlands correspondence as a statement about physical duality — is developed in [11], building on Tate's thesis; that work notes that Dragovich's program has realized the template for free theories and that a conformal-field-theory proof of concept exists. We adopt this template: our adelic state space (Section 3) is the state-space analogue of Tate's restricted product $\mathbb{A}_{\mathbb{Q}} = \mathbb{R} \times \prod'_p \mathbb{Q}_p$. The arithmetic equidistribution theorem of [1] (Baker–Rumely, Favre–Rivera–Letelier, and independently Chambert-Loir) shows that points of small height on the Berkovich projective line equidistribute with respect to an adelic measure; this is the closest existing mathematical analogue of our coherence condition, in which local contributions at every place must balance to produce a global distributional statement. We use [1] as evidence that adelic product formulas with local weights are mathematically coherent and support limiting statements — precisely the structure our Born-rule recovery argument requires.

Measurement theory. The axiomatic characterization of apparatus statistics by completely positive maps [3] establishes that standard quantum mechanics fixes all admissible measurement statistics for nondegenerate observables; our model must reproduce these statistics in the selected completion, which is the content of our Born-rule recovery result (Section 4). The quantum Bayes principle of [5] derives state reduction without the projection postulate, using joint probability distributions for successive local measurements; this is methodologically parallel to our goal of deriving projection from dynamics rather than postulating it. The stochastic Schrödinger equation framework [2] describes continuous measurement as a diffusive unraveling of a master equation together with the spectrum of the measurement output; our place-selective coupling is modeled as exactly such an unraveling (Section 3), with the place index v playing the role that the measurement record plays in [2]. The definite-outcomes analysis of [6] shows that entangled states are coherent superpositions of nonlocal correlations between incoherently mixed local states, so that even macroscopic subsystems need not carry definite local states; this supports our claim that definiteness is a property of *couplings* rather than of states — in our language, of place-selection. The quantum Turing machine analysis of [4] characterizes measurement, preparation, and halting as *local transition functions* on a discrete state space; the locality of these transitions is the computational analogue of our place-locality of apparatus coupling, and the discrete-protocol vocabulary may offer a route to simulating place-crossing on classical hardware. Finally, [8] shows that joint nonlocal measurements, in QFT and even non-relativistically, generically produce signaling unless restricted to ideal measurements — a caution that our place-selective coupling must be local in the place index to avoid analogous pathologies; we impose this as an axiom (Section 3).

Hardware context. Superconducting quantum processors with high-fidelity readout, such as the 105-qubit Tianyan-287 platform with readout fidelity 98.7% [7], illustrate the precision with which measurement statistics are now verified; any adelic correction to Born statistics would be constrained far below this level, which we quantify as a bound in Section 5.

3. Methods

3.1 Adelic Hilbert space

Let $\mathbb{A}_{\mathbb{Q}}$ be the adèle ring of $\mathbb{Q}$: the restricted product $\mathbb{A}_{\mathbb{Q}} = \mathbb{R} \times \prod'_p \mathbb{Q}_p$, where all but finitely many p -adic components lie in $\mathbb{Z}_p$. For each place $v \in \{\infty, 2, 3, 5, \dots\}$ let H_v be a separable Hilbert space over the local field $\mathbb{Q}_v$ (with $\mathbb{Q}_{\infty} = \mathbb{R}$). The adelic state space is the restricted tensor product

$$H_{\mathbb{A}} = \bigotimes_v' H_v,$$

the closure of finite linear combinations of product vectors $\bigotimes_v \psi_v$ with ψ_v in a fixed reference state $|e_v\rangle$ for all but finitely many v (the analogue of Tate's integrality condition).

Coherence condition (Product Formula). The global inner product of two product states is the adelic product of local inner products:

$$\left\langle \bigotimes_v \phi_v, \bigotimes_v \psi_v \right\rangle_{\mathbb{A}} = \prod_v \langle \phi_v, \psi_v \rangle_v,$$

which converges because all but finitely many factors equal 1. This mirrors the adelic product formula $\prod_v |x|_v = 1$ for $x \in \mathbb{Q}^{\times}$ and the equidistribution balance of [1]. The global norm factorizes over places, $\|\Psi\|_{\mathbb{A}}^2 = \prod_v \|\psi_v\|_v^2$; this factorization is the structural origin of our Born-rule conjecture (Section 4, Derivation 4).

3.2 Place-selective coupling

An apparatus localized at place v_0 couples through an operator L_{v_0} acting nontrivially only on H_{v_0} . We model the apparatus as a bath of N_b place-localized modes and postulate the Lindblad-type master equation for the reduced density matrix $\rho_v(t)$ at each place:

$$\frac{d\rho_v}{dt} = -\frac{i}{\hbar} [H_v, \rho_v] + \lambda_v^2 N_b \left(A_v \rho_v A_v^{\dagger} - \frac{1}{2} \{A_v^{\dagger} A_v, \rho_v\} \right),$$

where λ_v is the place-selective coupling strength and A_v the apparatus pointer operator at place v . The off-diagonal (inter-place coherence) element between places v and w obeys, by standard Lindblad algebra applied to the product structure,

$$\rho_{vw}(t) = \rho_{vw}(0) e^{-\Gamma_{vw} t}, \quad \Gamma_{vw} = \frac{1}{2} (\Gamma_v + \Gamma_w), \quad \Gamma_v = \lambda_v^2 N_b \sigma_A^2,$$

with $\sigma_A^2 = \Delta A_v^2$ the pointer variance, assumed place-independent for the solvable model. This is the *completion-selective suppression equation*: coherence across places dies exponentially, and the surviving place is the one with the largest Γ_v , i.e., the place where the apparatus lives. The structure is the direct adelic analogue of the diffusive unraveling of [2], with the place index replacing the measurement-record index.

Locality axiom. Following the lesson of [8] that nonlocal joint measurements produce signaling, we require L_{v_0} to act on H_{v_0} alone; cross-place couplings L_{vw} with $v \neq w$ are forbidden in the model. This is what makes the projection "completion-selective" rather than a signaling channel.

3.3 Solvable model: two-place system

We restrict to two places, $v = \infty$ (real) and $v = 3$ (ternary), with a two-level system at each place. The initial state is the coherent product

$$|\Psi(0)\rangle = \alpha |\psi_\infty^+\rangle |\psi_3^+\rangle + \beta |\psi_\infty^-\rangle |\psi_3^-\rangle, \quad |\alpha|^2 + |\beta|^2 = 1,$$

and the apparatus couples at $v = \infty$ with coupling λ_∞ ; no apparatus exists at $v = 3$, so $\lambda_3 = 0$ in the bare model, but we allow a residual environmental coupling $\lambda_3 > 0$ to study leakage. The observable statistics in the selected completion are computed from $\rho_\infty(t)$, and we verify they converge to the Born distribution $|\alpha|^2, |\beta|^2$ as inter-place coherence vanishes — the mechanism being the same local-incoherence resolution of [6], transplanted to the place index.

4. Analysis

All numbers in this section are derived; every input is stated with its source.

Input 1 (model choice, Section 3.3): pointer variance $\sigma_A^2 = 1$ (chosen so that A_v has unit variance; any other choice rescales Γ by σ_A^2).

Input 2 (model choice): bath size $N_b = 10^{23}$, the canonical Avogadro-scale count of modes in a macroscopic apparatus; this is a modeling assumption, not a measurement.

Input 3 (model choice): coupling ratio. We set $\lambda_\infty = 2\lambda_3$, i.e., the apparatus coupling is twice the residual 3-adic environmental coupling. This ratio is a free parameter of the model; we choose 2 for definiteness.

Input 4 (model choice): absolute coupling $\lambda_\infty = 10^{-12}$ (dimensionless).

Derivation 1 (suppression rates). With $\Gamma_v = \lambda_v^2 N_b \sigma_A^2$:

$$\begin{aligned} \Gamma_\infty &= \lambda_\infty^2 N_b \sigma_A^2 = \lambda_\infty^2 \cdot 10^{23} \cdot 1 = 10^{23} \lambda_\infty^2, \\ \Gamma_3 &= \lambda_3^2 N_b \sigma_A^2 = \left(\frac{\lambda_\infty}{2}\right)^2 \cdot 10^{23} = \frac{10^{23} \lambda_\infty^2}{4} = 0.25 \times 10^{23} \lambda_\infty^2. \end{aligned}$$

Hence the rate ratio:

$$\frac{\Gamma_\infty}{\Gamma_3} = \frac{10^{23} \lambda_\infty^2}{0.25 \times 10^{23} \lambda_\infty^2} = \frac{1}{0.25} = 4.$$

Derivation 2 (inter-place coherence decay). The cross-place coherence $\rho_{\infty,3}(t)$ decays at

$$\Gamma_{\infty 3} = \frac{1}{2}(\Gamma_\infty + \Gamma_3) = \frac{1}{2}(1 + 0.25) \times 10^{23} \lambda_\infty^2 = 0.625 \times 10^{23} \lambda_\infty^2.$$

Setting $\lambda_\infty = 10^{-12}$ (Input 4), so $\lambda_\infty^2 = 10^{-24}$:

$$\Gamma_{\infty 3} = 0.625 \times 10^{23} \times 10^{-24} = 0.625 \times 10^{-1} = 6.25 \times 10^{-2},$$

in units of inverse model-time. The $1/e$ coherence time is

$$T_{\times} = \frac{1}{\Gamma_{\infty 3}} = \frac{1}{6.25 \times 10^{-2}} = 16.$$

So inter-place coherence dies with characteristic time $T_{\times} = 16$ in model units.

Derivation 3 (suppression of the non-selected completion). The population decay rate of the $v = 3$ sector's coherent dynamics is Γ_3 :

$$\Gamma_3 = 0.25 \times 10^{23} \times 10^{-24} = 0.25 \times 10^{-1} = 0.025.$$

After one coherence time $t = T_{\times} = 16$, the residual coherence is

$$|\rho_{\infty,3}(16)| = |\rho_{\infty,3}(0)| e^{-\Gamma_{\infty 3} \cdot 16} = |\rho_{\infty,3}(0)| e^{-1} \approx 0.3679 |\rho_{\infty,3}(0)|,$$

and after $t = 5T_{\times} = 80$:

$$|\rho_{\infty,3}(80)| = |\rho_{\infty,3}(0)| e^{-5} \approx 6.738 \times 10^{-3} |\rho_{\infty,3}(0)|.$$

Derivation 4 (Born-rule recovery and the place-prior conjecture). Take $|\alpha|^2 = 0.6$, $|\beta|^2 = 0.4$ (model choice). With residual coherence $c(t) = \rho_{\infty,3}(t)$, the outcome probabilities in the selected completion are

$$P_+(t) = |\alpha|^2 + \operatorname{Re} c(t), \quad P_-(t) = |\beta|^2 - \operatorname{Re} c(t),$$

so that $P_+ + P_- = 1$ identically. At $t = 0$, take $c(0) = \alpha\beta^*$ with $|\alpha\beta^*| = \sqrt{0.6 \times 0.4} = \sqrt{0.24} \approx 0.4899$ (maximally coherent product state). Then

$$P_+(0) = 0.6 + 0.4899 = 1.0899, \quad P_-(0) = 0.4 - 0.4899 = -0.0899,$$

which is unphysical — the signature of un-decohered inter-place coherence. At $t = 80$:

$$c(80) = 0.4899 \times e^{-5} = 0.4899 \times 6.738 \times 10^{-3} \approx 3.301 \times 10^{-3},$$

$$P_+(80) = 0.6 + 3.301 \times 10^{-3} = 0.6033, \quad P_-(80) = 0.4 - 3.301 \times 10^{-3} = 0.3967.$$

The deviation from the Born distribution is $\delta = 3.3009 \times 10^{-3}$, i.e., 0.33 percentage points, and it decays as $e^{-\Gamma_{\infty 3} t}$.

Independently, under the product-formula coherence condition with a *conjectured uniform place-prior*, the probability of selecting place v_0 is $\Pr(v_0) = \|\psi_{v_0}\|_{v_0}^2$. For the toy model with $\|\psi_{\infty}\|_{\infty}^2 = |\alpha|^2 = 0.6$ and $\|\psi_3\|_3^2 = |\beta|^2 = 0.4$:

$$\Pr(\infty) + \Pr(3) = 0.6 + 0.4 = 1.$$

The normalization of the place-prior is guaranteed by the coherence condition; what is conjectural is the *uniformity* of the prior over places, which we flag as the framework's central open assumption (Section 6).

Derivation 5 (experimental consistency bound). The Tianyan-287 platform reports readout fidelity 98.7% [7], i.e., outcome-error probability $\epsilon = 1 - 0.987 = 0.013 = 1.3 \times 10^{-2}$. Requiring the adelic residual-coherence deviation to stay below this bound:

$$\delta(t) = \sqrt{|\alpha|^2 |\beta|^2} e^{-\Gamma_{\infty 3} t} \leq 1.3 \times 10^{-2}.$$

With the worst case $\sqrt{|\alpha|^2 |\beta|^2} = 0.5$ (equal superposition):

$$e^{-\Gamma_{\infty 3} t} \leq \frac{1.3 \times 10^{-2}}{0.5} = 2.6 \times 10^{-2},$$

$$\Gamma_{\infty 3} t \geq -\ln(2.6 \times 10^{-2}) = \ln \frac{1}{2.6 \times 10^{-2}} = \ln 38.46 \approx 3.6507.$$

With $\Gamma_{\infty 3} = 6.25 \times 10^{-2}$:

$$t \geq \frac{3.6507}{6.25 \times 10^{-2}} = 58.41.$$

So in model units, place-coherence must be suppressed by $t \gtrsim 58.4$ (about 3.65 coherence times) before adelic deviations fall below the 1.3×10^{-2} readout-error floor of [7].

5. Results

All results below are analytic consequences of the model of Section 3 with the inputs of Section 4; none are empirical measurements.

- **R1 (Rate ratio, derived).** With $\lambda_{\infty} = 2\lambda_3$, the completion-suppression rates satisfy $\Gamma_{\infty}/\Gamma_3 = 4$ (Derivation 1). Generally, $\Gamma_{\infty}/\Gamma_3 = (\lambda_{\infty}/\lambda_3)^2$.
- **R2 (Coherence timescale, derived).** Inter-place coherence decays at $\Gamma_{\infty 3} = 0.625 \Gamma_{\infty}$; with $\lambda_{\infty} = 10^{-12}$ and $N_b = 10^{23}$, $\Gamma_{\infty 3} = 6.25 \times 10^{-2}$ and $T_{\times} = 16$ model-time units (Derivation 2).
- **R3 (Suppression, derived).** Residual inter-place coherence is $e^{-1} \approx 0.3679$ of its initial value at $t = T_{\times}$ and $e^{-5} \approx 6.738 \times 10^{-3}$ at $t = 5T_{\times} = 80$ (Derivation 3).
- **R4 (Born-rule recovery, derived).** For $|\alpha|^2 = 0.6$, $|\beta|^2 = 0.4$, the selected-completion statistics converge from unphysical values $P_+(0) = 1.0899$, $P_-(0) = -0.0899$ to $P_+(80) = 0.6033$, $P_-(80) = 0.3967$, a deviation $\delta = 3.3009 \times 10^{-3}$ from Born weights, decaying exponentially (Derivation 4).
- **R5 (Experimental consistency bound, derived).** Requiring adelic deviations below the readout-error floor $\epsilon = 1.3 \times 10^{-2}$ of the 105-qubit Tianyan-287 platform [7] requires suppression time $t \geq 58.41$ model units (≈ 3.65 coherence times) in the worst-case equal superposition (Derivation 5).

Projection (explicitly labeled as such). If the model-time unit is identified with a microscopic collision timescale $\tau \sim 10^{-13}$ s (a standard order-of-magnitude for molecular timescales; this identification is an assumption, not a derivation), then $T_{\times} \sim 16 \times 10^{-13}$ s $= 1.6 \times 10^{-12}$ s and full suppression to the [7] bound occurs within $t \sim 58.41 \times 10^{-13}$ s $\approx 5.84 \times 10^{-12}$ s. (This identification of model time with physical time is an assumption; the factor-100 uncertainty from λ_{∞} applies.) The uncertainty in this projection is dominated by the assumed τ and by the coupling $\lambda_{\infty} = 10^{-12}$, which enters Γ quadratically: a factor-10 uncertainty in λ_{∞} gives a factor-100 uncertainty in $T_{\times}$.

6. Discussion

What is solved and what is not. The model derives an effective projection *within* the selected place by standard dephasing dynamics — this is not new relative to decoherence theory [2], [6]. The new structural claim is the *selection of the place itself*, and here the framework is weakest: the uniform place-prior of Derivation 4 is a conjecture, and we have no dynamics that selects the Archimedean place over a p -adic one. If the prior is not uniform, the Born-rule analogy fails or requires a weighted prior whose origin is unexplained — arguably relocating rather than solving the measurement problem. A skeptic will further note that the model reproduces Born statistics

because we inserted a Lindblad equation whose stationary states are diagonal — the adelic dressing may be epicyclic. Our reply: the nontrivial content is the *prediction of which completion survives* (the apparatus's place) and the *quantitative scaling* $\Gamma \propto \lambda^2 N_b$, which is falsifiable in principle if place-residual effects are ever resolvable.

Limitations. The model is deliberately minimal: two places, two levels, a phenomenological Lindblad equation with postulated rate $\Gamma_v = \lambda_v^2 N_b \sigma_A^2$. We did not derive the Lindblad form from an adelic Hamiltonian; we imported it from open-system theory [2] and verified its consistency with place-locality [8]. The bath size $N_b = 10^{23}$ and coupling $\lambda_\infty = 10^{-12}$ are free parameters; the qualitative conclusion (exponential suppression, Born recovery) is parameter-independent, but every timescale is not. The identification of model time with physical time is an unproven assumption (Section 5, projection). The restricted product requires almost all local factors to sit in a reference state; the dynamics of *leaving* the reference state (i.e., how a place becomes "active") is unspecified. The model is nonrelativistic; an adelic version of microcausality is undeveloped. The equidistribution results for adelic measures [1] suggest a mechanism for place-emergence but have not been connected to dynamics here. Finally, no experimental signature currently distinguishes this model from ordinary decoherence at the selected place, since R4 is operationally identical to standard decoherence from within one place — a serious weakness we acknowledge.

Failure modes. (i) If $\lambda_3 = 0$ exactly, the 3-adic sector never decoheres and the model predicts persistent inter-place coherence — potentially observable as anomalous statistics, but also possibly rendering the model inconsistent with the observed universality of Born statistics. (ii) If the product-formula coherence condition fails for interacting (non-free) systems, the adelic state space may not exist beyond free theories, collapsing the program to the free-case results of the Dragovich line [11]. (iii) The place-selective coupling could reintroduce the signaling pathology of [8] if any cross-place term is admitted; our axiom forbids it, but forbidding it may be too strong for relativistic settings.

What would falsify the claims. The framework is falsified if (a) a consistent adelic unitary dynamics exists that does *not* factorize over places, breaking the coherence condition; (b) a simulation of the adelic harmonic oscillator coupled to a place-specific bath shows cross-place interference persisting at strong place-specific coupling; or (c) a no-go theorem shows that any place-selective projection violates the statistical axioms of [3]. Observation of Born-statistics violations beyond 1.3×10^{-2} in high-fidelity platforms [7], uncorrelated with known systematic error, would be evidence *for* residual place-coherence; the absence of such violations to ever-tighter bounds progressively constrains λ_3/λ_∞ .

Open questions. What selects the Archimedean place in practice — the apparatus's own number-theoretic constitution, or a global boundary condition? Does the Langlands-type local-global machinery [11] constrain the couplings λ_v , turning a free parameter into a predicted number? Can the equidistribution theorems [1] be repurposed to derive the place-prior dynamically? Do the quantum Bayes derivation of reduction [5] and the correlation-based resolution of [6] lift to the adelic setting unchanged? Can the discrete-protocol vocabulary of [4] (local transitions, halting) offer a constructive route to simulating place-crossing on classical hardware?

7. Conclusion

We have articulated a conjectural, structurally grounded reframing of quantum measurement: states are adelic, apparatuses are place-bound, and measurement is completion-selective projection. Within a minimal two-place model we derived, with full arithmetic, exponential suppression of inter-place coherence at rate $\Gamma_{\infty 3} = 0.625 \Gamma_\infty$, a rate ratio $\Gamma_\infty/\Gamma_3 = (\lambda_\infty/\lambda_3)^2 = 4$ for the chosen couplings, Born-rule recovery with residual deviation 3.3009×10^{-3} after five coherence times, and a consistency bound of $t \geq 58.41$ model units against the 1.3×10^{-2} readout-error floor of state-of-the-art platforms [7]. The program's value, if it survives, is a number-theoretic account of why collapse selects the Archimedean world; its risk is that the adelic structure is decoration on standard decoherence. The falsifiable scalings identified here mark the boundary between the two.

References

- [1] Quasi-adelic measures and equidistribution on $\mathbb{P}^1$. arXiv:1502.04660v3. <https://arxiv.org/abs/1502.04660v3> [2] Quantum continuous measurements: The stochastic Schroedinger equations and the spectrum of the output. arXiv:1301.3626v2. <https://arxiv.org/abs/1301.3626v2> [3] Quantum Measurement, Information, and Completely Positive Maps. arXiv:quant-ph/0107090v1. <https://arxiv.org/abs/quant-ph/0107090v1> [4] Quantum Turing Machines: Local Transition, Preparation, Measurement, and Halting. arXiv:quant-ph/9809038v1. <https://arxiv.org/abs/quant-ph/9809038v1> [5] Quantum State Reduction and the Quantum Bayes Principle. arXiv:quant-ph/9705030v1. <https://arxiv.org/abs/quant-ph/9705030v1> [6] Solution of the problem of definite outcomes of quantum measurements. arXiv:1705.01495v3. <https://arxiv.org/abs/1705.01495v3> [7] Tianyan: Cloud services with quantum advantage. arXiv:2512.10504v2. <https://arxiv.org/abs/2512.10504v2> [8] Towards a measurement theory in QFT: "Impossible" quantum measurements are possible but not ideal. arXiv:2311.13644v2. <https://arxiv.org/abs/2311.13644v2> [9] <https://papers.qnfo.org/papers/measure-theoretic-artifacts-adelic-completion/>. QNFO: Measure-Theoretic Artifacts of the Archimedean Place — v2.0: The Completion Problem, the Langlands Connection, and the Adelic Restructuring of Fundamental Physics. [10] <https://papers.qnfo.org/papers/measure-theoretic-artifacts-archimedean-place/>. QNFO: Measure-Theoretic Artifacts of the Archimedean Place: A Complete Taxonomy and the Adelic Restructuring of Fundamental Science. [11] <https://papers.qnfo.org/papers/tate-adelic-template/>. QNFO: Tate's Thesis as a Template for Adelic Quantum Mechanics: Local-Global Structure and the Emergence of Archimedean Artifacts.

Appendix A. Divergence report

The independent drafts diverged on the following substantive points; each divergence is documented with the convention chosen for the main text.

- **D1 (choice of finite place).** Draft A used the 2-adic place ($\mathbb{R}$ vs. $\mathbb{Q}_2$); Draft B left the finite place generic ($v = p$ for an unspecified prime p); Draft C used the 3-adic place ($\mathbb{R}$ vs. $\mathbb{Q}_3$). The disagreement is purely conventional: no derived quantity in the paper depends on which prime is chosen, since every rate scales as $\Gamma_v = \lambda_v^2 N_b \sigma_A^2$ with the prime entering only as a label. **Convention chosen for the main text:** the 3-adic place (Draft C), so that all worked arithmetic in Sections 4–5 refers to $v = 3$. Re-running Derivations 1–5 with $v = 2$ changes no numerical result.
- **D2 (residual finite-place coupling).** Draft A set $\lambda_3 = 0$ exactly (bare model, no leakage); Draft B allowed $\lambda_3 > 0$ as a residual environmental coupling. **Convention chosen for the main text:** Draft B's version, $\lambda_3 = \lambda_\infty/2 > 0$, because it permits the leakage analysis of Derivations 1–3 and the falsifiability discussion of Section 6; the $\lambda_3 = 0$ case is retained as failure mode (i) in Section 6.
- **D3 (coupling ratio).** Draft A used $\lambda_\infty = 10 \lambda_3$; Drafts B and C used $\lambda_\infty = 2 \lambda_3$. **Convention chosen for the main text:** the ratio 2 (majority of drafts); the general result $\Gamma_\infty/\Gamma_3 = (\lambda_\infty/\lambda_3)^2$ stated in R1 covers the alternative, which would give $\Gamma_\infty/\Gamma_3 = 100$ and correspondingly faster suppression.
- **D4 (status of the place-prior).** Draft A presented the uniform place-prior as a postulate of the model; Draft B flagged it as the framework's central open assumption. **Convention chosen for the main text:** Draft B's framing (Conjecture in the Abstract, flagged in Derivation 4 and Section 6), since the prior is not derived from any dynamics in this paper.

Appendix B. Claim attribution

Substantive claims extracted from the independent drafts, with source attribution and agreement status (CONVERGENT: at least two drafts agree in substance; DIVERGENT: drafts conflict; SINGLE: one draft only).

Claim	Statement	Sources	Status
C1	By Ostrowski's theorem, the completions of $\mathbb{Q}$ are $\mathbb{R}$ and the $\mathbb{Q}_p$; standard quantum mechanics is formulated over the Archimedean place only.	A, B, C	CONVERGENT
C2	Measurement is a place-crossing event: a place- v_0 apparatus projects the joint adelic state onto the v_0 -completion.	A, B, C	CONVERGENT
C3	Adelic state space is the restricted tensor product $H_{\mathbb{A}} = \bigotimes'_v H_v$ with product-formula inner product.	A, B, C	CONVERGENT
C4	Inter-place coherence decays as $\rho_{vw}(t) = \rho_{vw}(0) e^{-\Gamma_{vw}t}$ with $\Gamma_{vw} = \frac{1}{2}(\Gamma_v + \Gamma_w)$, $\Gamma_v = \lambda_v^2 N_b \sigma_A^2$.	A, B, C	CONVERGENT
C5	Finite place is $v = 2$ (A), generic $v = p$ (B), or $v = 3$ (C).	A, B, C	DIVERGENT (D1; resolved to $v = 3$)
C6	Residual finite-place coupling: $\lambda_3 = 0$ (A) vs. $\lambda_3 > 0$ (B, C).	A, B, C	DIVERGENT (D2; resolved to $\lambda_3 > 0$)
C7	Coupling ratio $\lambda_{\infty}/\lambda_3 = 10$ (A) vs. 2 (B, C).	A, B, C	DIVERGENT (D3; resolved to 2)
C8	Rate ratio $\Gamma_{\infty}/\Gamma_3 = (\lambda_{\infty}/\lambda_3)^2$; equals 4 for the chosen couplings.	A, B, C	CONVERGENT (value depends on D3)
C9	With $\lambda_{\infty} = 10^{-12}$, $N_b = 10^{23}$, $\sigma_A^2 = 1$: $\Gamma_{\infty 3} = 6.25 \times 10^{-2}$ and $T_{\times} = 16$ model units.	B, C	CONVERGENT
C10	Born-rule recovery: for $ \alpha ^2 = 0.6$, $ \beta ^2 = 0.4$, deviation $\delta = 3.301 \times 10^{-3}$ at $t = 80$.	B, C	CONVERGENT
C11	Consistency bound $t \geq 58.4$ model units against the 1.3×10^{-2} readout-error floor of [7].	B, C	CONVERGENT
C12	Uniform place-prior conjecture $\Pr(v_0) = \ \psi_{v_0}\ _{v_0}^2$ underlies Born-rule recovery; its uniformity is the central open assumption.	A, B, C	CONVERGENT in substance; DIVERGENT in status (D4; resolved to open assumption)
C13	Locality axiom forbidding cross-place couplings L_{vw} , motivated by the signaling caution of [8].	B, C	CONVERGENT
C14	Physical-time projection $T_{\times} \sim 1.6 \times 10^{-12}$ s via $\tau \sim 10^{-13}$ s, explicitly labeled a projection.	C	SINGLE
C15	Failure mode: $\lambda_3 = 0$ exactly predicts persistent inter-place coherence.	A, B	CONVERGENT