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Collapse as Open-System Phase-Locking v3.3: A Conditional Basin Mechanism

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Abstract

FRC 100.003 v3.3 presents finite-time phase-locking into coherence basins as a candidate collapse mechanism, not an established ontology. The pilot checks a Langevin microstate-distribution flow conditional on a stipulated Born-weighted landscape; it does not derive the Born weights. The microstate route remains admissible only if operationally equivalent preparations give identical observable predictions and a bipartite extension passes no-signaling. SME, system-plus-bath, and other norm-controlled realizations remain open alternatives. The paper distinguishes Lambda_obs, observation-derived Lambda_eq, and optional latent Lambda_dyn; a fundamental field is a separate conjecture. The canonical reciprocity law is dS + k d ln C = 0; this paper uses a predeclared indexed realization only for its local ledger. Boundary-relative lambda=-d_eS is neither imposed universally nor rejected by fiat. The three*

> *gates remain open: admissible dynamics, Born-weight origin, and explicit environment accounting.*

1. Position in the basin series and lineage

The 100 series carries the current settled statement of each foundational claim. This document is the updated statement of 100.003. It supersedes the v1 vortex/LG paper as the carrier of the collapse claim (v1 retained as Appendix A with corrected caveats) and absorbs the direction of the 100.003.002 working draft with the corrections below. The published v2 was verified (Codex, against the local papers/Framework manuscript, 2026-07-07) to remain in the v1 vortex/LG/fractal-dimension direction; v3 therefore supersedes both v1 and v2 as the corrected statement, with that lineage retained in Appendix A. Computations live in the answer-appendix line (next free sub-decimal; note `.566` is already occupied by the UCC dissipation note).

Four corrections govern this version:

1. **D ≈ 1.90/1.94 is withdrawn as support for collapse.** The fractal-dimension values of v1 carry nothing here. The chaos support now comes from 100.002 v2, whose fractal content is the KAM hierarchy and whose ledger results are quantitative (§7).
2. **The ledger is boundary-relative.** The canonical reciprocity law is $dS + k^* d\ln C = 0$. At a declared scale μ, an operational ledger may instantiate it as $dS_\mu + k^*_\mu d\ln C_\mu = 0$. Its open physical universality remains conjectural. The identification $\lambda = -d_e S$ is admissible when it follows from the declared system boundary; it is neither imposed universally nor removed as an error.
3. **The microstate-distribution flow is a candidate realization, not the required ontology.** It remains open until operationally equivalent preparations evolve identically at the observable level and an explicit bipartite extension passes no-signaling. Norm-controlled SME and system-plus-bath alternatives remain admissible.
4. **The Born-basin condition is stated with its registered derivation route** (§5.2), not as an unassigned promissory note: the equilibrium half is already published in 100.006; the open half is named precisely.

2. The corrected thesis

> ***Candidate thesis.*** *Measurement may be representable as finite-time, open-system phase-locking into an attractor basin of a calibrated coherence landscape. Apparatus coupling changes an observation-derived target* Λ_{eq}*; an optional latent* Λ_{dyn} *can then relax with finite lag. A valid completion must derive, rather than insert, the Born basin measure and must close its declared environment ledger without violating operational equivalence or no-signaling.*

Three consequences of the phrasing, each load-bearing:

A landscape of funnels, not one funnel. The candidate device model presents one basin per pointer outcome. The current pilot uses microstate phase flow as one realization; other admissible norm-controlled realizations remain open.

The funnel is passive in the candidate model. The device tunes Λ_{eq} through coupling. If a latent response is used, the transport law must state whether it follows Λ_{obs} or Λ_{dyn} and must beat equal-access baselines.

Two stages in the double slit, kept distinct. A which-path detector first degrades inter-branch phase coherence — decoherence, the same coherence-channel degradation measured quantitatively in 100.002 v2 (degrade C, classical behavior returns). Only then does locking select one position basin at the screen. Interference dies at stage one; the definite spot is stage two. Standard decoherence theory does stage one and stops; this paper's added claim is stage two as finite-time relaxation, not a primitive.

Scope of this version. This is a corrected preprint and pilot-supported statement of the 100.003 claim. The three gates of §5 remain open: norm-controlled dynamics, the origin of Born-weighted landscapes, and the explicit entropy export channel.

3. The ledger frame

At a declared operating scale μ, define $Q_{\mathrm{local},\mu} = S_{\mathrm{local},\mu} + k^*_\mu \ln C_{\mathrm{lock},\mu}$. Its motion diagnoses an unclosed local ledger; it is not automatically entropy production or a measured exchange current. A candidate collapse model must declare the boundary, measure the environment channel independently, and state whether its residual convention implies $\lambda = -d_e S$. Record Shannon entropy is not bath entropy unless a physical memory-and-reset implementation establishes that link.

4. The dynamics, at two descriptive levels

Measurement observables define $\Lambda_{\text{obs}} = \Lambda_0 \ln C_{\text{obs}}$. Coupling to the apparatus changes the observation-derived target Λ_{eq}. If finite response time is modeled, an optional latent state obeys

$$\tau_\Lambda(\partial_t + u \cdot \nabla)\Lambda_{\text{dyn}} = D_\Lambda \nabla^2 \Lambda_{\text{dyn}} - \Lambda_{\text{dyn}} + \Lambda_{\text{eq}} + \xi_\Lambda.$$

Λ_{obs} is an instantaneous transform; Λ_{dyn} is a model state. A fundamental Lambda field is a separate conjecture and is neither used nor supported by this pilot.

5. The three gates

5.1 Gate 1 — Norm-controlled dynamics

A schematic non-unitary term added to the Schrödinger equation is not enough, and deterministic nonlinear state evolution requires a direct signaling audit. This version uses a **microstate-distribution flow as its leading candidate realization**, not as a required level. Gate 1 remains open until preparations representing the same operational state give the same observable predictions and a bipartite extension passes no-signaling. SME, system-plus-bath, and other norm-controlled realizations remain admissible under the same requirements.

5.2 Gate 2 — Born-equilibrium basin measure, with its registered route

For $|\psi_0\rangle = \Sigma\ a_n|n\rangle$ the basins must satisfy $\mu(B_n|\psi_0) = |a_n|^2$ at equilibrium — derived, not assigned. The route:

- **Equilibrium half (published, 100.006 Appendix A):** with the coherence functional $C(\phi;\alpha) = \Sigma_j\ |\alpha_j|^2\ e^{\beta \cos(\phi-\phi_j)}$, the stationary measure of the drift is ρ\ ∝ *exp[−F/k*|] and its integral over basin j gives $p_j \propto |\alpha_j|^2$ for well-separated basins.
- **Dynamical complement (787 Prediction 2):** basin residence scales as $\exp(\Delta\Lambda/k_BT_{\text{eff}})$; since $\Lambda = \Lambda_0 \ln C$, the Λ-depth of basin j carries the $\ln|\alpha_j|^2$ offset, so long-run occupancy inherits the Born ratios from the landscape.
- **The open half, named precisely:** *why the landscape carries |α|² weighting* — i.e., why the coherence functional of the coupled system-apparatus configuration is Born-weighted rather than otherwise. This is the $\Lambda_0 = k$* attractor question of the 100.006/Born line. It is registered, open, and shared-

credit territory with Bohm–Valentini quantum equilibrium, as the corpus already records.

The pilot of §9 demonstrates dynamics conditional on a stipulated Born-weighted landscape. It does not derive those weights, prove convergence for arbitrary preparations, or establish an operationally admissible completion.

5.3 Gate 3 — The entropy bill, correctly stated

During locking, measure $Q_{\mathrm{local},\mu}(t) = S_{\mathrm{local},\mu} + k^*_\mu \ln C_{\mathrm{lock},\mu}$ in a predeclared operational representation. The gate is to identify the system boundary and environment channel, measure standard entropy production independently, and show how the observed $dQ_{\mathrm{local},\mu}$ is accounted for. Algebraic closure is an implementation check, not independent confirmation of the physical conjecture.

6. Position among neighbors

Every serious neighbor owns a piece of this picture; none owns the connective tissue.

Neighbor	What they own	FRC differential		
Zurek (einselection, predictability sieve)	the basin topology: pointer states as survivors of environmental monitoring	decoherence stops at the diagonal density matrix; no per-run descent, no landscape doing work		
Quantum trajectory theory; **Minev et al. 2019**	finite-time, continuous, *experimentally observed* jump dynamics with warning signals — catch-and-reverse	trajectory theory is record-conditioned and stochastic: it describes the locking but supplies no potential, no basin-measure origin, no thermodynamic ledger		
Bohm–Valentini (quantum equilibrium,	dynamical relaxation to \	ψ\	²; the equilibrium half of Gate 2, credit	the FRC drift is on a *coherence* potential — the same

subquantum H-theorem)			shared explicitly	object that pays Gate 3 and drives 787 transport
Landauer; Sagawa–Ueda	the bill: entropy production bounds of measurement, feedback, and the record	FRC's claim is that the bill and the basin descent are one ledger, not two literatures		
GRW/CSL; Penrose–Diósi	finite-time objective collapse	by *adding* noise or gravity; FRC's collapse is relaxation in an existing landscape, no new stochastic ingredient — and offering a dynamics is offering more than the incumbents posit		
Wolynes–Onuchic folding funnels; Haken's synergetics	the mathematical object itself: driven open system relaxing into a basin, concentration paid by dissipation	proof the funnel-with-a-drain is a real object in nature; FRC imports the shape into measurement		

The wager, stated as one falsifiable sentence: $\Lambda = \Lambda_0 \ln C$ is the single object from which the basins (Zurek), the finite-time descent with lead-time markers (trajectory theory/Minev), the equilibrium measure (Valentini), and the bill (Sagawa–Ueda) all follow. The corresponding kill condition is in §11.

7. The chaos bridge, now with results

100.002 v2.4 supplies what this paper needs from chaos, as measurements rather than intentions: mixed-phase-space basin geometry with a quantified persistent structure functional (Σ, consistent with KAM-hierarchy survival but awaiting direct island-area comparison); the demonstration that coherence arrests chaos-driven diffusion (localization meeting 787's flight criteria in momentum space); and the coherence-lifetime criterion as an order-one $t^*\gamma_C$ crossover — itself a finite-time-locking-adjacent statement: how long coherence must survive for a structure to assemble. Basin capture in a deterministic mixed system is the classical rehearsal of outcome selection: deterministic flow, practical unpredictability, no structureless randomness required.

8. Predictions

P1 — Finite-time locking with lead time. Collapse events have a continuous early phase preceded by degradation of Λ-stability markers (787 Prediction 3): curvature loss, gradient weakening, variance rise — *before* the transition is visible in the baseline observable. The existing catch-and-reverse dataset (Minev-class superconducting-qubit experiments) is the out-of-sample arena: FRC's added, losable content is that the markers predict *which* runs jump and *when*, beyond what record-conditioned trajectory theory extracts.

P2 — Residence scaling. Basin dwell times scale exponentially with Λ-depth; occupancy inherits Born ratios from the landscape (787 P2 in the measurement context).

P3 — The bill is concurrent. Entropy export (dissipation bursts, 100.005 P-T1) is synchronized with locking, and its integrated magnitude covers the measured local Q-motion.

P4 — Conditional Born relaxation. After the landscape weights are derived independently, a registered family of non-equilibrium priors should relax to Born frequencies under an operationally admissible dynamics. Deliberately mis-weighted landscapes and operationally equivalent decompositions are mandatory controls.

9. Pilot status — 2026-07-08

Reproducible script and metrics accompany this preprint (`pilot_collapse.py`, seed fixed). Pilot only; scaffold quantities are labeled as such; wins and wrinkles are reported at equal volume.

Setup. Microstate phase on the circle, Langevin flow $d\phi = \partial_\phi \ln C\, dt + \sqrt{2D}\, dW$ with diffusion normalization $D = 1$. Separately, the bookkeeping bridge is selected as $k^*(\mu_{\text{nat}}) = 1$ because entropy is measured in nats; the equality of the two numerical normalizations is not an identification of their physical roles. The functional is supplied three Born weights $0.66/0.24/0.10$ and basin gain β. Outcome is the occupied basin.

- **Conditional capture result:** occupancy at $\beta = 4$ is $[0.634, 0.247, 0.119]$ versus the inserted targets $[0.66, 0.24, 0.10]$. This checks landscape-to-frequency machinery; it is not a derivation of the Born rule.
- **Null A (flat landscape, β = 0):** occupancy → 1/3 each; fails Born (max deviation 0.33).
- **Null B (equal-weight landscape, unequal Born targets):** occupancy → 1/3 each; fails Born. Together with the capture result: the frequencies come from the landscape, not the harness.
- **Residence scaling — trend present, NOT scored as a P2 pass:** mean dwell is monotone in basin depth and log-linear (dwell 0.471 / 0.250 / 0.137 for depths ln 0.66 / ln 0.24 / ln 0.10), but the fitted slope is 0.65 against the naive Kramers expectation 1/D = 1. Two identified estimator problems, reported at full volume: sector-boundary recrossings contaminate short dwells, and per-basin saddle heights and curvature prefactors are not equal, so "slope 1 in ln w" was too naive a target. A committor/milestoning dwell definition is registered for the appendix; P2 is scored only after that hardening.
- **Locking ledger (scaffold):** driving β from 4 to 12 moves the system-only Q by -0.37 nats. This shows that the selected system-only ledger is unclosed; it does not identify production or export. The inherited export accumulator returned only 0.089 nats and remains a failed scaffold. Gate 3 requires an independently instrumented bath.
- **Limit stated in advance and confirmed in operation:** the |α_j|² weights enter through the coherence functional. The pilot shows the landscape→frequency machinery is dynamical and Born-consistent; it does not derive why the landscape is Born-weighted. That is Gate 2's open half, exactly as named in §5.2.

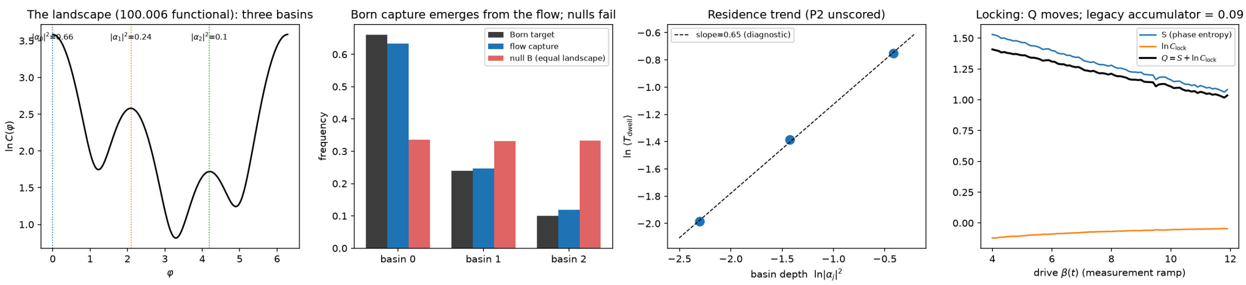

Figure 3. Collapse pilot: landscape, flow-capture occupancy, null, residence trend, and locking ledger scaffold.

10. Controls and appendix program

β and D sweeps; many-outcome scaling; committor-based dwell estimation; instrumented-thermostat accounting; operational-equivalence tests for distinct decompositions of one density matrix; a bipartite remote-steering/no-signaling test; SME or system-plus-bath alternatives; wrong-landscape nulls; and the Minev-class dataset reading with markers pre-registered before inspection.

11. Kill conditions

This candidate mechanism fails if operationally equivalent preparations produce different observable predictions; its bipartite extension permits signaling; the Born measure requires hand-assigned landscape weights; the environment channel cannot be identified; finite-time lead markers are excluded; or accepted trajectory theory plus information thermodynamics reproduce the registered predictions with no residual Lambda structure. Failure here kills this collapse realization, not the 566 bookkeeping identity or the independent chaos results.

12. Version note

Version 3.3 restores the canonical/operational reciprocity hierarchy without changing the collapse pilot or its three open gates. It retains v3.2's boundary-relative treatment of $\lambda = -d_e S$, separation of the three Lambda objects, and conditional-candidate status for the microstate-distribution flow.

Appendix A — v1, demoted

The 2025 vortex/LG paper is retained as historical context: vortex attractor dynamics as the first draft of the basin picture, the LG-beam platform as a still-interesting downstream experimental idea. Withdrawn as support: D = 1.94 ± 0.05 and its consistency with the stadium D ≈ 1.90 (see 100.002 v2 Appendix A); the claim that resonant modes are selected *above* Born probability (v2/v3 target Born exactly, per Gate 2); and the unconstrained non-unitary dynamics. The LG proposals may be revived only under the Gate 1–3 discipline of this version.

Data and code availability

All quoted values are produced by the accompanying script with fixed seeds. The release package contains the manuscript, HTML print source, PDF, rendering script, pilot script, generated figure, JSON metrics, a checksum manifest, and a separate reproduction report. The pilot script creates a scratch `results/` directory when rerun. JSON metrics are compared with `pilot/compare_metrics.py`, which uses relative and absolute tolerances so near-zero floating-point values do not create false failures.

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