

The Ignorant Observer — Technical Core

Keystone claims, equations, and empirical status

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This brief states the load-bearing claims and equations of the Ignorant Observer Framework (IOF) and its operational module, Bandwidth-Limited Quantum Control (BLQC), together with their empirical status. It is an entry point to the full papers, not a substitute. **The framework reproduces standard quantum mechanics exactly**; what it adds is a measured control law on the observer’s tracking of its own measurement basis, and — through it — a calibrated instrument for objective-reduction tests.

1. Setup. The measurement basis θ is not an external dial but a physical reference the apparatus generates and must track: a phase, field direction, pulse phase, or timing gate. Write the ideal interference contribution as $I_{\text{int}} \propto \cos(\phi - \theta)$, with ϕ the system phase. A finite-rate controller holds an estimate $\hat{\theta}$ of the realized reference $\theta = \theta_0 + \delta\theta$, where $\delta\theta$ is the unresolved *tracking error* — not fundamental quantum noise.

2. The threshold. Reference dynamics generate unresolved information at the Kolmogorov–Sinai rate h_{KS} ; the tracking loop constrains the reference at effective capacity C_{eff} . Data-rate logic (the Data-Rate Theorem; Nair–Evans 2004, Tatikonda–Mitter 2004) gives a self-ignorance rate

$$\kappa = h_{\text{KS}} - C_{\text{eff}} \ln 2 \quad (\text{ideal}), \quad \kappa_{\text{cal}} = h_{\text{KS}} - \eta C_{\text{eff}} \ln 2 \quad (\text{tested}),$$

where $\eta \in (0, 1]$ is the loop’s coding efficiency, the ideal κ recovered at $\eta = 1$. η is **measured once in an electronics-only calibration arm and frozen** before any quantum data are taken; inferring C_{eff} or η from the visibility data under test is prohibited. This “no free capacity scale” rule is what keeps the κ -collapse non-circular. Two regimes follow: *capacity-wins* ($\kappa < 0$), where textbook fixed-basis quantum mechanics is operationally available; and *chaos-wins* ($\kappa > 0$), where the online reference is unresolved.

3. Visibility law. Averaging the interference term over a wrapped-Gaussian basis uncertainty of width σ_θ gives $\langle \cos(\phi - \theta) \rangle = \cos(\phi - \theta_0) e^{-\sigma_\theta^2/2}$, hence the observer-relative visibility factor

$$V_{\text{IOF}} = \exp\left(-\frac{1}{2}\sigma_\theta^2\right), \quad V_{\text{obs}} = V_{\text{std}} \cdot V_{\text{IOF}}.$$

This is the *exact* first circular moment of the wrapped Gaussian, not a small-angle approximation; V_{std} is the ordinary physical visibility (including environmental decoherence), which the framework does not modify.

4. The key ansatz, and its justification. In the chaos-wins regime the unresolved variance is closed at the net information-deficit rate,

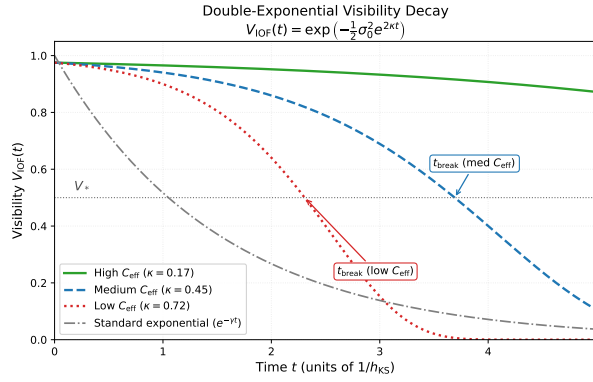
$$\frac{d}{dt} \ln \sigma_\theta^2 = 2\kappa \implies \sigma_\theta^2(t) = \sigma_0^2 e^{2\kappa t} \implies \boxed{V(t) = \exp\left(-\frac{1}{2}\sigma_0^2 e^{2\kappa t}\right)} \quad (\text{double-exponential}).$$

Justification. A high-rate, converse-type rate–distortion bound for tracking a chaotic source, $R(D; t) \approx h_{\text{KS}} t + \frac{1}{2} \ln(\sigma_0^2/D)$, set against the information $C_{\text{eff}} t \ln 2$ the channel can deliver, yields the variance law as a *lower envelope*: no tracker does better, and the envelope is attained only by near-optimal tracking. The equality is therefore the **minimal effective closure — an ansatz, not a theorem** — and is labelled as such. The form holds only within a certified dynamic range ($\sigma_\theta \lesssim 1$ rad, posterior first-harmonic-dominated); beyond it higher cumulants enter and the suppression saturates at the circular-uniform floor rather than decaying without bound.

5. The primary observable. For a visibility threshold V_* (so $\sigma_{\text{tol}}^2 = -2 \ln V_*$), the breakdown time is

$$t_{\text{break}} = \frac{1}{2\kappa} \ln\left(\frac{-2 \ln V_*}{\sigma_0^2}\right) \propto \frac{1}{\kappa}, \quad \frac{\partial t_{\text{break}}}{\partial C_{\text{eff}}} > 0, \quad \frac{\partial t_{\text{break}}}{\partial h_{\text{KS}}} < 0.$$

The signature is a near-unity plateau followed by a sharp knee, qualitatively distinct from exponential ($e^{-\gamma t}$) or Gaussian (e^{-t^2}) decay. Caveat, stated up front: the bend is only statistically separable from the closest ordinary-decay curve once the observation window reaches t_{break} ; an experiment that stops short cannot discriminate at any shot count.



Chaos-wins signature for three tracking capacities: lower C_{eff} (higher κ) breaks earlier; plateau-then-knee, unlike standard exponential decoherence (grey).

6. Empirical ledger. Four hypotheses, with their status:

- H_{null} — standard QM with a noisy finite-bandwidth reference. *Baseline.*
- H_{op} — the operational control law: online loss collapses against κ_{cal} . *Consistent with H_{null} ; a control-theoretic refinement, not a rival.* Reproduces QM exactly; the loss is recoverable by conditioning on a logged reference.
- H_{strong} — an unrecoverable, κ -scaled residual beyond QM. *Excluded* for diffusive and externally randomized references by logged-setting Bell tests (Weihs et al. 1998), randomized-measurement tomography, and clock correlation spectroscopy. Open only in the certified-deterministic-chaotic corner, prior strongly against.
- H_{OR} — a κ -independent, unrecoverable visibility floor following mass geometry (Penrose objective reduction). *The live test*, run on a mesoscopic platform with the engineered channel off and tracking maximal.

Two axes. By construction the engineered benchmark is *blind* along the BLQC-vs-null axis — both predict identical κ -scaling and identical recoverability, because both are standard physics. That blindness is precisely what makes the benchmark a *calibration*, and it is why the discriminating axis is mass geometry, not κ .

7. What it buys (three consequences). (i) The Heisenberg cut acquires a measured location: the boundary sits where $\kappa = 0$, making the quantum/classical divide a design-dependent, measurable feature. (ii) The calibrated, recoverable reference channel is a *subtrahend* for objective-reduction searches: subtract it, and any residual unrecoverable mass-geometry floor stands clear — turning an OR null from inconclusive into a quantitative bound, and a detection harder to fool. (iii) One falsifiable fork remains open — the certified-chaotic strong-tier corner.

8. What keeps it honest. The chaos-wins law requires the realized reference trajectory to be *certified expanding* (positive largest Lyapunov exponent), discriminated from stochastic diffusion by surrogate-data null tests; additive noise on a stable loop does not qualify. Every attempted configuration is reported (gate-failure accounting), and a passive, causally isolated high-resolution shadow log supplies the recovery statistic R_{rec} that classifies each loss as recoverable reference physics or candidate collapse.

9. Foundations note. Separately, the binary single-system Born weight $p(\theta) = \cos^2(\theta/2)$ is reconstructed from finite-record Fisher–Rao geometry under two explicit bridge assumptions (companion paper); the same finite-record invariance admits no invariant phase structure, so the multi-outcome rule and phase remain hosted. This is a conditional module, not an independent derivation of quantum mechanics, and nothing in the visibility law above depends on it.

Full treatment: *The Ignorant Observer* (foundational); *Bandwidth-Limited Quantum Control* (operational benchmark); *A Capacity-Calibrated Protocol for Testing Penrose Objective Reduction* (the OR test). All at <https://www.ignorantobserver.xyz>.