Incompleteness, Null Signals, and the Cosmological Plenum

1. Gödelian Incompleteness and the Limits of Formal Systems

Kurt Gödel's incompleteness theorems (1931) establish a fundamental limit on formal systems: any system expressive enough to encode arithmetic contains true propositions that are unprovable within its axioms. This is not a deficiency but a structural necessity of categoricity. By defining a formal domain—whether mathematical, logical, or computational—one excludes the metalevel conditions embedding it. Completeness within a category entails incompleteness with respect to its superset, setting the philosophical foundation for this inquiry: all systems of order are provisional, locally coherent, and globally incomplete, requiring mechanisms to signal their boundaries.

2. Null Convention Logic as Embodied Incompleteness

Karl Fant's null convention logic (NCL), as presented in *Computer Science Reconsidered* (2007), operationalizes incompleteness at the hardware level. Unlike synchronous digital logic, which relies on an external clock, NCL introduces a null state alongside binary 0 and 1, signifying readiness, waiting, or incompletion. This allows circuits to self-signal their operational status without an external oracle. Everyday analogues include:

- A "Do Not Disturb" sign, suspending action and signaling unavailability.
- A learner's permit, encoding partial readiness toward full capability.
- An amber traffic light, indicating imminent change rather than a definitive command.

The null state is not an absence but a meaningful signal that prevents premature interpretation, embodying Gödelian incompleteness in practical systems.

3. Critiques of GOFAI and the Role of Null States

Monica Anderson's critiques of Good Old-Fashioned Artificial Intelligence (GOFAI) highlight the limitations of rule-based, symbolic systems. GOFAI assumes intelligence can be fully captured through explicit formalisms, but such systems falter when faced with ambiguity or incomplete information. Anderson advocates for sub-symbolic, data-driven approaches (e.g., neural networks) that handle uncertainty through adaptive, partial states, akin to NCL's null signals. Where GOFAI halts without a rule, sub-symbolic systems defer judgment, learning from incomplete data and mirroring the null state's role in acknowledging systemic limits.

4. Functional Programming and Deferred Entropy

Pure functional programming employs monads to delay side-effects, preserving referential transparency until interaction with the external world is required. This parallels NCL's null state, maintaining computation within a safe, incomplete zone. Ilya Prigogine's dissipative structures provide a thermodynamic analogue: systems like hurricanes or economies sustain internal order by exporting entropy to their environment. In computer science, garbage collection defers memory management; in economics, platforms externalize costs. Incompleteness and entropy are not eliminated but displaced, a universal strategy for managing systemic boundaries.

5. RSVP and the Cosmological Extension

The Relativistic Scalar-Vector-Potential (RSVP) model reinterprets cosmological redshift as an entropic relaxation process, driven by three fields:

- Scalar capacity Ξ, mediating entropic smoothing, analogous to NCL's null signal.
- Vector field $\mathbf{u}$, representing bulk flows and local deviations.
- Entropy field S, quantifying disorder redistributed during structure formation.

The entropic redshift potential, $\Upsilon \equiv \delta\Phi - \beta(\eta)\varphi_m$, where $\varphi_m = \frac{4\pi G a^2(\eta)\bar{\rho}_m(\eta)}{k^2}\mathcal{T}_m(k,\eta)\delta_m(k,\eta)$, combines gravitational ($\delta\Phi$) and entropic (φ_m) effects. Ξ defers structural relaxation, driving the outward expansion of cosmic voids without requiring exotic vacuum energy (see Appendix B for a detailed analogy to "falling outward").

6. Dipole Constraints and Cosmological Homogeneity

The Cosmic Microwave Background (CMB) dipole provides stringent constraints on super-horizon inhomogeneities. In RSVP, the temperature anisotropy is:

$$\frac{\Delta T}{T}(\hat{\mathbf{n}}) = \hat{\mathbf{n}} \cdot \frac{\mathbf{u}_0}{c} + \frac{1}{3}\Upsilon_*(\hat{\mathbf{n}}) + 2\int_{\eta_*}^{\eta_0} \dot{\Upsilon}\, d\eta$$

The kinematic dipole ($\varepsilon_{\text{kin}} \sim 10^{-3}$) dominates, while the intrinsic dipole is bounded by:

$$\Delta\Upsilon_* \equiv \|\nabla\Upsilon_*\| R_* \text{few} \times 10^{-5}$$

This, combined with the small quadrupole ($\sim 10^{-5}$), implies homogeneity and isotropy extend beyond the observable horizon, disfavoring bubble universes with radically different parameters (see Appendix A for detailed constraints). RSVP's entropic dynamics ensure global coherence, suppressing arbitrary parameter variations.

7. Synthesis

Incompleteness is an architectural principle across domains. Gödel's theorems reveal formal limits; NCL's null signals enable adaptive circuits; Anderson's GOFAI critiques advocate for subsymbolic flexibility; functional programming defers side-effects; Prigogine's structures export entropy; and RSVP's Ξ field drives cosmic relaxation. Each system functions by signaling its limits, whether through unprovable propositions, null states, or entropic potentials. The CMB's isotropy reinforces this coherence, suggesting a universe constrained by global conditions, not a probabilistic ensemble. As in Matthew 26:29, drinking the wine marks a fulfilled state, opening a larger, incomplete horizon—a cosmos of null signals, perpetually falling outward within a greater whole.

Appendix A: CMB Dipole Constraints in RSVP Terms

A.1 Fields, Normalization, and ΛCDM Dictionary

The RSVP framework employs:

- Scalar capacity Ξ (entropic smoothing),
- Matter density $\delta\rho_m$ (inward gravitational pull),

- Bulk flow **u** (peculiar velocity).

The entropic redshift potential is:

$$\boxed{\Upsilon \equiv \delta\Phi - \beta(\eta)\,\varphi_m, \quad \varphi_m(k,\eta) = \frac{4\pi G\,a^2(\eta)\,\bar{\rho}_m(\eta)}{k^2}\,\mathcal{T}_m(k,\eta)\,\delta_m(k,\eta)}$$

Normalized such that the Sachs–Wolfe contribution at decoupling is:

$$\boxed{\left(\frac{\Delta T}{T}\right)_{\text{SW}} = \frac{1}{3}\Upsilon_*}$$

with $\beta(\eta_*) = \frac{4\pi G\,a^2(\eta_*)\,\bar{\rho}_m(\eta_*)}{k^2}\mathcal{T}_m(k,\eta_*)$.

A.2 Large-Angle Anisotropy

For a sightline $\hat{\mathbf{n}}$:

$$\frac{\Delta T}{T}(\hat{\mathbf{n}}) = \underbrace{\hat{\mathbf{n}}\cdot\frac{\mathbf{u}_0}{c}}_{\text{kinematic dipole } \varepsilon_{\text{kin}}\sim 10^{-3}} + \underbrace{\frac{1}{3}\Upsilon_*(\hat{\mathbf{n}})}_{\text{entropic SW}} + \underbrace{2\int_{\eta_*}^{\eta_0}\dot{\Upsilon}\,d\eta}_{\text{entropic ISW}}$$

The intrinsic dipole is:

$$\left|\left(\frac{\Delta T}{T}\right)^{\text{int}}_{\ell=1}\right| \equiv \varepsilon_{\text{int}}\text{few} \times 10^{-5}$$

A.3 Super-Horizon Gradient Bound

A super-horizon inhomogeneity is modeled as:

$$\Upsilon(\mathbf{x},\eta) \simeq \Upsilon_0(\eta) + \mathbf{G}(\eta)\cdot\mathbf{x}, \quad \|\mathbf{G}\|R_* \ll 1$$

The intrinsic dipole contribution is:

$$D_{\text{int}} \approx \frac{1}{3}\|\mathbf{G}_*\|R_* + \mathcal{O}\left(\int \dot{\Upsilon}\,d\eta\right)$$

with bounds:

$$\boxed{\|\nabla\Upsilon_*\|R_* 3\varepsilon_{\text{int}}} \quad \Longleftrightarrow \quad \boxed{\|\mathbf{G}_*\|\frac{3\varepsilon_{\text{int}}}{R_*}}$$

A.4 Effective Potential

The effective potential is:

$$\boxed{\mathbf{a}_{\text{eff}} = -\nabla\Phi_{\text{eff}}, \quad \Phi_{\text{eff}} \equiv \Phi - \gamma(\eta)\varphi_m}$$

with bounds:

$$\boxed{|\delta\Phi|_*\varepsilon_{\text{int}}, \quad |\delta\rho_m|_*\frac{\varepsilon_{\text{int}}}{\alpha_m}}$$

where $\alpha_\Phi = 1$ at decoupling.

A.5 Bulk-Flow Convergence

The RSVP bulk-flow estimator is:

$$\mathbf{u}_0^{\text{RSVP}}(R) := \arg\min_{\mathbf{u}} \sum_{i:r_i<R} w_i\left(z_i^{\text{obs}} - z_i^{\text{RSVP}}(\mathbf{u})\right)^2, \quad w_i \propto \frac{1}{\sigma_{S,i}}$$

Converging as:

$$\angle\left(\mathbf{u}_0^{\text{RSVP}}(R), \mathbf{d}_{\text{CMB}}\right) \to 0, \quad \|\mathbf{u}_0^{\text{RSVP}}(R)\| \to c\varepsilon_{\text{kin}}$$

A.6 Long-Mode Consistency

Super-horizon adiabatic modes cancel the leading dipole, with residuals tied to the quadrupole ($\sim 10^{-5}$), tightening the bound in A.3.

A.7 Conclusion

The residual dipole limit, $\Delta\Upsilon_{*}$few$\times 10^{-5}$, and bulk-flow alignment indicate homogeneity extends beyond the observable horizon, disfavoring bubble universes.

Appendix B: Falling Outward in the RSVP Framework

Consider a spherical region in the RSVP plenum with a test particle at its boundary, governed by Ξ, **u**, and S.

Case 1: Matter-Dominated Sphere. For matter-rich regions, the effective energy is:

$$E \sim -\frac{GMm}{r},$$

driving inward collapse.

Case 2: Entropic Vacuum-Dominated Sphere. In void-like regions dominated by Ξ, the "mass" scales as $M(r) \propto r^3$, yielding:

$$E \sim -r^2$$

This drives outward relaxation, with entropy generated by the fall itself.

Inflationary Extension. In the early plenum, a high-entropy Ξ dominates, producing a lamphron-lamphrodyne flash:

$$E \sim -\rho_{\Xi} r^2, \quad \frac{d^2 r}{dt^2} \propto \rho_{\Xi} r$$

This rapid smoothing establishes causal uniformity, prefiguring void expansion. The CMB dipole constraint ($\Delta\Upsilon_{*}$few $\times 10^{-5}$) ensures this coherence persists, ruling out arbitrary parameter variations.