IPI Letters

Erratum

Erratum:
Holographic Information Rate as a Resolution to Contemporary Cosmological Tensions

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An error in the numerical calculation of the universal information processing rate γ has been identified in the above paper and in two related works: "E-mode Polarization Phase Transitions Reveal a Fundamental Parameter of the Universe" [1] and "Destroying the Multiverse: Entropy Mechanics in Causal Diamonds" [2]. This erratum provides the corrected derivation and numerical values, explains the source of the error, and confirms that the theoretical frameworks and their principal conclusions remain valid.

The original papers reported $\gamma \approx 1.89e - 29$ with the claim that $\gamma/H \approx 1/8\pi \approx 0.040$. These two statements are internally inconsistent: with $H_0 = 2.18e - 18$, the reported value $\gamma = 1.89e - 29$ would yield $\gamma/H_0 \approx 8.7 \times 10^{-12}$, not $1/8\pi \approx 0.040$. This nine-order-of-magnitude discrepancy indicates a fundamental error in the original numerical evaluation.

The information processing rate $\gamma(z)$ emerges from the holographic principle applied to cosmological horizons. The Bekenstein-Hawking entropy of the Hubble-volume causal diamond is $S_{\max} = \mathcal{A}/(4G\hbar) = \pi c^5/(G\hbar H^2)$, where $\mathcal{A} = 4\pi c^2/H^2$ is the horizon area. The Margolus-Levitin bound [4] constrains the maximum rate of orthogonal quantum state transitions to $f_{\max} = 2E/(\pi\hbar)$. The characteristic energy within the Hubble volume scales as $E \sim c^5/(GH)$, yielding $f_{\max} \sim (2/\pi)S_{\max}H$. The information processing rate per horizon degree of freedom is suppressed by the information-theoretic cost of addressing individual Planck-area cells on the holographic screen, encoded in the dimensionless horizon area $N_P \equiv \mathcal{A}/\ell_P^2 \propto S_{\max}$. Requiring that a single processing cycle update all Planck-scale degrees of freedom once per Hubble time yields:

$$\gamma(z) = \frac{H(z)}{\ln N_P} = \frac{H(z)}{\ln\left(\frac{\pi c^5}{G\hbar H(z)^2}\right)} \tag{1}$$

This is the central information-theoretic postulate: $\gamma(z)$ has dimensions of inverse proper time and serves as the intrinsic rate parameter along timelike worldlines.

At the present epoch ($z = 0$), using $H_0 = 2.180e - 18$ (67.27 km/s/Mpc), $c = 2.998e8$, $\hbar = 1.055e - 34$, and $G = 6.674e - 11$, the logarithmic argument evaluates to $\pi c^5/(G\hbar H_0^2) \approx 2.27 \times 10^{122}$, giving $\ln(\pi c^5/G\hbar H_0^2) \approx 281.7$. The corrected present-epoch value is therefore:

$$\gamma_0 = \frac{H_0}{281.7} = \frac{2.180 \times 10^{-18}}{281.7} = 7.74e - 21 \qquad (2)$$

with the corrected dimensionless ratio $\gamma_0/H_0 = 1/281.7 \approx 3.55 \times 10^{-3} \approx 1/282$. The discrepancy factor between the incorrect and correct values is $\sim 4.1 \times 10^8$.

At recombination ($z \approx 1100$), the Hubble parameter evaluated using Planck 2018 best-fit cosmological parameters [5] is $H(z = 1100) \simeq 4.5e - 14$. The logarithmic argument becomes $\pi c^5/(G\hbar H^2)|_{z=1100} \approx 1.1 \times 10^{113}$, giving $\ln(\cdot) \approx 260$. The information processing rate at recombination is therefore $\gamma(z = 1100) = (4.5 \times 10^{-14})/260 \approx 1.7e - 16$. The ratio γ/H remains approximately constant across cosmic epochs because the logarithmic factor varies slowly with H: $\gamma(z)/H(z) \approx 1/\ln(S_{\max}(z)) \sim 10^{-3}$.

The fundamental theoretical structures of all three papers remain valid because the error concerns only the numerical evaluation of γ, not its functional form or the physical principles from which it derives. The QTEP ratio $\eta = \ln(2)/(1 - \ln(2)) \approx 2.257$ derives from von Neumann entropy of maximally entangled two-qubit systems and contains no dependence on γ. The entropy values $S_{\text{coh}} = \ln(2) \approx 0.693$ nats and $S_{\text{decoh}} = \ln(2) - 1 \approx -0.307$ nats emerge from quantum information theory and thermodynamic irreversibility requirements, independent of cosmological parameters. The ebit-obit framework and causal diamond geometry based on Gibbons-Solodukhin formulas [3] remain valid. The functional form $\gamma(z) = H(z)/\ln(\pi c^5/G\hbar H(z)^2)$ correctly captures the information-processing rate as a function of cosmic epoch.

In "E-mode Polarization Phase Transitions" [1], the analysis of CMB E-mode polarization phase transitions at multipoles $\ell_1 = 1750 \pm 35$, $\ell_2 = 3250 \pm 65$, and $\ell_3 = 4500 \pm 90$ remains valid. The geometric scaling ratio of $2/\pi$ between successive transitions is a dimensionless quantity that does not depend on the absolute value of γ. The claim $\gamma/H \approx 1/8\pi$ must be corrected to $\gamma/H \approx 1/282$. Equation (6) should read $\gamma(z) = H(z)/\ln(\pi c^5/G\hbar H(z)^2)$, correcting c^2 to c^5 in the numerator to restore dimensional consistency. Replace $\gamma = 1.89e - 29$ with epoch-appropriate values: $\gamma_0 = 7.74e - 21$ at $z = 0$, or $\gamma \approx 1.7e - 16$ at recombination. The relation $(\gamma t_P)^2 \approx \rho_\Lambda/\rho_P$ (Equation 29) requires re-evaluation with the corrected γ value.

In the above paper, the resolution of BAO scale tensions, S_8 parameter discrepancies, and matter density measurement inconsistencies proceeds through modified evolution equations incorporating information-theoretic constraints. The correction term $-\gamma H\delta$ in the perturbation equation involves the product γH, which scales as $H^2/\ln(S_{\max})$. The relevant quantity for cosmological observables is the dimensionless combination $\gamma/H \sim 10^{-3}$, not the absolute value of γ in SI units. The claim $\gamma/H = 1/8\pi \pm 0.004$ (Equation 1) must be corrected to $\gamma/H \approx 1/282 \approx 3.5 \times 10^{-3}$. Replace $\gamma = 1.89e - 29$ with $\gamma_0 = 7.74e - 21$. The numerical coefficients in predictions (Equations 30–32) should be re-evaluated using $\gamma/H \approx 1/282$ rather than $1/8\pi$.

In "Entropy Mechanics in Causal Diamonds" [2], the functional form $\gamma(z) = H(z)/\ln(\pi c^5/\hbar G H(z)^2)$ is correct as stated. Replace any numerical instances of $\gamma_0 \approx 1.89e - 29$ with $\gamma_0 = 7.74e - 21$. The reservoir temperatures derived from γ require correction: the original values $T_{\text{coh}} \approx 2.87e - 64$ and $T_{\text{decoh}} \approx 6.48e - 64$ should be replaced with $T_{\text{coh}} = \hbar\gamma_0/(k_B \ln 2) \approx 8.5e - 33$ and $T_{\text{decoh}} = \hbar\gamma_0/(k_B(1 - \ln 2)) \approx 1.9e - 32$. The temperature ratio remains unchanged: $T_{\text{decoh}}/T_{\text{coh}} = (1 - \ln 2)/\ln 2 \approx 0.443$, confirming that the thermodynamic structure is preserved. The entropy mechanics framework establishing quantum measurement as thermodynamic entropy partition within causal diamond structures, the refutation of the Many Worlds Interpretation, and all dimensionless ratios and entropy values remain unchanged.

The error originated from an early draft calculation that was not updated when the theoretical framework was refined. The incorrect value $\gamma \approx 1.89e - 29$ appears to have been computed using an incorrect dimensional analysis or an erroneous intermediate result that was then propagated across manuscripts. The simultaneous claim that $\gamma/H \approx 1/8\pi$ was not verified against the numerical value, creating an internal inconsistency that went undetected. The correct derivation from the holographic principle yields $\gamma/H = 1/\ln(S_{\max})$, where $S_{\max} \sim 10^{122}$ at the present epoch, giving $\gamma/H \approx 1/282$. The value $1/8\pi \approx 0.040$ has no fundamental significance in this context.

The corrected value can be independently verified using the following Python code:

```
import math
c, hbar, G, H0 = 2.998e8, 1.055e-34, 6.674e-11, 2.180e-18
S_max = (math.pi * c**5) / (G * hbar * H0**2)  # ~2.27e122
gamma_0 = H0 / math.log(S_max)                 # ~7.74e-21 s^-1
print(f"gamma_0 = {gamma_0:.2e}, gamma_0/H0 = {gamma_0/H0:.4f}")
```

In summary, the numerical value of γ requires correction by a factor of $\sim 4 \times 10^8$ across three published works. The corrected values are $\gamma_0 = 7.74e - 21$ at the present epoch, $\gamma(z = 1100) \approx 1.7e - 16$ at recombination, and $\gamma/H \approx 1/282 \approx 3.5 \times 10^{-3}$ (approximately constant across epochs). The claim $\gamma/H \approx 1/8\pi$ appearing in the original papers is incorrect and should be replaced with $\gamma/H \approx 1/\ln(S_{\max}) \approx 1/282$. The theoretical frameworks presented in all three papers remain valid because their principal conclusions depend on the functional form of $\gamma(z)$, dimensionless ratios, and scaling relationships rather than the absolute numerical value of γ at any single epoch. Future work referencing these papers should use the corrected values provided herein.

References

[1] Weiner, B. (2025). E-mode Polarization Phase Transitions Reveal a Fundamental Parameter of the Universe. *IPI Letters*, 3(1), 31–39. doi:10.59973/ipil.150

[2] Weiner, B. (2025). Destroying the Multiverse: Entropy Mechanics in Causal Diamonds. *IPI Letters*, 3(5), 25–39. doi:10.59973/ipil.269

[3] Gibbons, G. W. and Solodukhin, S. N. (2007). The geometry of small causal diamonds. *Phys. Rev. D*, 76, 044009. doi:10.1103/PhysRevD.76.044009

[4] Margolus, N. and Levitin, L. B. (1998). The maximum speed of dynamical evolution. *Physica D*, 120, 188–195. doi:10.1016/S0167-2789(98)00054-2

[5] Planck Collaboration (2020). Planck 2018 results. VI. Cosmological parameters. *Astronomy & Astrophysics*, 641, A6. doi:10.1051/0004-6361/201833910