TFPT — Appendix H: the horizon unit system

One seam constant $c_3 = \frac{1}{8\pi}$ as the universal horizon thermal code
(Hawking, de Sitter, Unruh, Page, scrambling — *standard physics in seam units, not new gravity*)

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What this document is about

A change of bookkeeping, not new gravitational physics: if gravity is the geometry-channel readout of the seam, then *all* horizons read the same boundary constant $c_3 = \frac{1}{8\pi}$. This note collects the readouts — Hawking, de Sitter and Unruh temperature, black-hole thermodynamics, the Page time, scrambling, the Nariai bound, $v_{\mathrm{GW}} = c$ and cosmic birefringence — in seam units, with two genuine compiler fingerprints ($1920 = |W(D_5)|$, $|\mu_4| = 4$).

The TFPT document set — what is treated where

Plain language: TFPT is a small discrete compiler. Two inputs — the seam constant $c_3 = \frac{1}{8\pi}$ and the carrier rank $g_{\mathrm{car}} = 5$ — build $D_5 \oplus A_3 + \mu_4 \Rightarrow E_8$ and read off the Standard Model, the constants and the scale grammar. The development is **five short documents plus this appendix**, best read in order:

1. `introduction` — reading guide, compiler closure, paper-by-paper comparison, predictions, the dependency DAG and proof ledger.
2. `tfpt_1_architecture_e8` — the two axioms, the derivation map, the EM fixed point α^{-1}, the $D_5 \oplus A_3 + \mu_4 \Rightarrow E_8$ construction.
3. `tfpt_2_standard_model` — the SM in one φ_0-ladder formula, flavor from parabolic transport, the worked closures, and gravity/QG as the seam response.
4. `tfpt_3_e8_audit_bootstrap` — the seven E_8 slices as an audit raster, the cascade bridge, the Möbius bootstrap.
5. `tfpt_4_frontier` — honest status of η_B, m_p/m_e, Koide, dark matter, full QG.

H. `tfpt_horizon_readouts` — **Appendix H**: one seam constant as the universal horizon thermal code (a unit-system reframe, *not* a peer paper, *not* new physics).

You are reading Appendix H — a notation/unit reframing; all new-physics content lives in documents 1–4.

Contents

Scope and honest typing

If gravity is the geometry-channel readout of the seam (companion note "Seam response grammar"), then horizons are not separate miracles — they all read the *same* boundary normaliser $c_3 = 1/(8\pi)$. This note collects the readouts. Markers: [P] standard horizon physics rewritten in TFPT/seam units (no new claim), [I] an exact compiler connection (audit-level), [N] a numerical readout (reproduced), [A] a search target, not a result. Nothing here is sold as new gravitational physics; it is a *change of bookkeeping* that exposes shared structure.

Unit conventions used throughout

Three unit systems appear; the seam factor $c_3 = 1/(8\pi)$ is the same number in all of them, only the carried dimensionful constants change:

system	convention	Hawking temperature
Planck	$G{=}\hbar{=}c{=}k_B{=}1$	$T_H = c_3/M = 1/(8\pi M)$
reduced Planck	$\bar{M}_{\rm Pl} = M_{\rm Pl}/\sqrt{8\pi}$, $\hbar{=}c{=}k_B{=}1$	$T_H = c_3\, \bar{M}_{\rm Pl}^2/M$
SI	restore $G, \hbar, c, k_B$	$T_H = \dfrac{\hbar c^3}{8\pi G k_B M} = c_3 \dfrac{\hbar c^3}{G k_B M}$

All boxed formulas below are in Planck units unless stated; the seam constant is dimensionless.

Standard references for the formulas reframed here: Hawking temperature and radiation (Hawking 1975); Bekenstein–Hawking entropy (Bekenstein 1973, Hawking 1975); Page time (Page 1993); fast scrambling $t_{\rm scr} \sim \beta \log S$ (Sekino–Susskind 2008, Maldacena–Shenker–Stanford 2016); Nariai bound (Nariai 1950); de Sitter thermodynamics (Gibbons–Hawking 1977). *Nothing below is a new derivation of these* — only a rewriting in the seam unit c_3.

1 The seam constant is the universal horizon temperature factor

Every Killing horizon has $T = \hbar\kappa/(2\pi c k_B)$. Since

$$\boxed{\frac{1}{2\pi} = 4c_3, \qquad \frac{1}{8\pi} = c_3} \qquad \text{[I]},$$

the universal factor *is* the seam constant: $T_{\rm hor} = 4c_3\, \hbar\kappa/(c k_B)$. Black holes, de Sitter and Unruh therefore share *one* thermal grammar. [P] [`verification/v8_horizon.py`]

2 Schwarzschild thermodynamics in four c_3-lines

For a non-rotating, uncharged hole in Planck units ($G{=}\hbar{=}c{=}k_B{=}1$):

$$\boxed{T_H = \frac{c_3}{M}, \qquad S_{BH} = \frac{M^2}{2c_3}, \qquad P_H = \frac{c_3}{1920\, M^2}, \qquad \tau_{\rm evap} = \frac{640}{c_3} M^3} \qquad \text{[P]}.$$

Two of the constants are compiler numbers, not coincidences:

- the Hawking temperature factor is $c_3 = 1/(8\pi)$ — the same P1 boundary normaliser; [I]

- the radiated-power denominator is $1920 = |W(D_5)|$, the Weyl-group order of the D_5 carrier. [I]

Scope of P_H: this is the idealised massless single-channel blackbody normalisation. Greybody factors and the radiated species content shift the phenomenological evaporation coefficient; the c_3-form is the convention statement, not a general phenomenological prediction.

object	T_H	**lifetime / entropy**
solar-mass hole	6.17×10^{-8} K	$\tau_{\rm evap} \approx 2.1 \times 10^{67}$ yr; $S/k_B \approx 1.05 \times 10^{77}$
PBH evaporating now (1.7×10^{11} kg)	$k_B T \approx 61$ MeV	relevant for γ/ν PBH signatures

3 Page time and scrambling

Since $S_{BH} \propto M^2$ and $\tau \propto M^3$, the Page point ($M \to M/\sqrt{2}$) is

$$t_{\rm Page} = \Big(1 - \tfrac{1}{2\sqrt{2}}\Big)\tau_{\rm evap} \approx 0.6464\,\tau_{\rm evap} \qquad \text{[P]}.$$

In TFPT the Page curve is *boundary recoverability*: the physical sector is OS-reconstructed and gapped, and the recovered mutual information decays at the transfer rate, $I(A{:}C|B)_n \sim \lambda_2^n = (2/3)^{6n}$. **This is the same operator that builds the Standard Model:** the boundary transport spectrum is $\{1, (2/3)^6, (1/3)^6\}$ and its sub-leading eigenvalue $\lambda_2 = (2/3)^6$ is exactly the flavor-gap eigenvalue of Paper 2 ($\Delta_{\rm gap} = -\log(2/3)^6 = 6\log\frac{3}{2}$). One boundary transport thus governs *both* the SM flavor hierarchy and the horizon information recovery. [I] [`verification/v54_seam_horizon_keystones.py`] The scrambling prefactor carries a μ_4 signature: with $\beta = 1/T_H = 8\pi M$, $\beta/2\pi = 4M$, so

$$\boxed{t_{\rm scr} \sim |\mu_4|\, M \log S} \qquad (|\mu_4| = 4) \qquad \text{[I]-audit.}$$

4 De Sitter and the Nariai bound from the Λ closure

With the action-grammar Hubble/Λ readouts ($H_0/\bar{M}_{\rm Pl} = e^{-\alpha_\star^{-1}}/(2\pi\sqrt{\Omega_\Lambda})$, $\rho_\Lambda/\bar{M}_{\rm Pl}^4 \sim e^{-2\alpha_\star^{-1}}$), the asymptotic de Sitter horizon gives

$$\boxed{\frac{T_{dS}}{\bar{M}_{\rm Pl}} = 16 c_3^2\, e^{-\alpha_\star^{-1}}, \qquad S_{dS} = \frac{e^{2\alpha_\star^{-1}}}{128 c_3^4} = 32\pi^4 e^{2\alpha_\star^{-1}} \approx 3.32 \times 10^{122}} \qquad \text{[P]}.$$

This is the area-law horizon capacity of the universe from $(\alpha_\star^{-1}, c_3, H_\Lambda)$ alone. The maximal black hole in de Sitter (Nariai) is

$$M_N \approx 2.16 \times 10^{22}\, M_\odot \approx 4.3 \times 10^{52}\,\text{kg}, \qquad S_N = \tfrac{1}{3} S_{dS} \qquad \text{[P]},$$

the absolute gravitational-capacity limit, not an observed structure.

5 Turnaround radius, gravitational waves, light

Bound structures. In a Λ-universe the maximal bound radius is $r_{\rm ta}(M) = \big(GM[\,2\pi e^{\alpha_\star^{-1}}/\bar{M}_{\rm Pl}]^2\big)^{1/3}$ — halo, cluster, supercluster and void scales follow from the Λ closure with no new parameter. [P]

Gravitational waves. The low-curvature branch is $R + R^2$; the tensor graviton runs on the Lorentz cone and the only extra mode (the scalaron, $M_{\rm scal} \approx 3.06 \times 10^{13}$ GeV) is frozen for astrophysical frequencies. Hence

$$\boxed{v_{\rm GW} = c} \qquad \text{(no measurable dispersion)} \qquad \text{[P]},$$

a clean falsifier: a genuine $v_{\rm GW} \neq c$ would break this gravity closure.

Light. TFPT does not predict the SI number c (definitional); it predicts the *universality of the causal cone* — RP → OS reconstruction → one Lorentzian cone shared by EM, gravity and massless modes ($v_\gamma = v_g = c$, no native photon dispersion). What it *does* compute is not a speed shift but a polarisation rotation, cosmic birefringence

$$\boxed{\beta_{\rm rad} = \frac{u}{4\pi} \approx 0.2424^\circ} \qquad \text{[N]},$$

from the same seed $u = \phi_0^{\rm ret}$ that fixes the Cabibbo angle, Ω_b and θ_{13}.

6 Search targets (not claims)

Audit-level search ansätze [A]

- **Black-hole echoes:** any near-horizon echo amplitude ratio would be a natural transfer-rate target, $\mathcal{A}_{n+1}/\mathcal{A}_n \lesssim (2/3)^6 \approx 0.0878$. A search ansatz, no prediction.
- **Quantum recovery:** the Page-curve recovery kernel $I \sim (2/3)^{6n}$ is a falsifiable shape if a boundary-recovery rate is ever measured.

Net

All horizon formulas share the one seam normalisation $1/(2\pi) = 4c_3$. Black-hole, de Sitter and Unruh temperatures, the Page time, scrambling, the Nariai bound, turnaround radii, $v_{\rm GW} = c$ and birefringence are *readouts of one seam constant* — standard physics rewritten in TFPT units, with two genuine compiler fingerprints ($1920 = |W(D_5)|$ in Hawking power, $|\mu_4| = 4$ in scrambling). No new gravitational physics is claimed; the value of the reframe is that horizons stop being separate modules.

Appendix: computational verification

The seam-unit identities of this note (the thermal grammar $\frac{1}{2\pi}$=$4c_3$, the power denominator 1920=$|W(D_5)|$, the de Sitter entropy form, the Page fraction, the scrambling $|\mu_4|$=4, and $\beta_{\rm rad}$=$\varphi_0^{\rm ret}/4\pi$=0.2424°) are re-derived and machine-checked in `verification/v8_horizon.py`. Run `python verification/v8_horizon.py` (needs `mpmath`); it imports the same c_3=$1/(8\pi)$ primitive as the rest of the suite. The search-target ansätze remain [A] and are deliberately not part of the pass/fail checks.