WILL
PART II - Cosmology

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Principle: **No metric, no free parameters, only algebraic closure.**

↓

Inherited: **Spacetime ≡ Energy Evolution** (Part I result)

↓

Critical cosmological identity:
$\boxed{\kappa^2 = \Omega = \rho/\rho_{\max}}$

↓

Geometric closure of cosmology:
$\boxed{\Lambda = \frac{\kappa^2}{r_d^2} = \frac{\kappa^2 H^2}{c^2}}$, $\boxed{H = c/r_d}$, $\boxed{\Omega_\Lambda = \kappa^2}$

↓

Prediction:
$\kappa^2 = \Omega_\Lambda = 2/3; \quad \Omega_m = 1/3$ (direct geometric result)

↓

Equation of state:
Maximal symmetry $\to P = -\rho \implies w = -1$

↓

Entropy and Zeno holographic cascade:
$S = \frac{A}{4l_P^2}$ via projectional loss at each new inner horizon $r_n = R_s/2^n$

↓

Physical consequences:
– Dark energy as cumulative projection loss
– All observables are algebraic consequences, no external parameters

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Abstract

In conventional cosmology, the Friedmann equations describe the evolution of the universe by solving differential equations involving the scale factor $a(t)$, energy densities, curvature k, and a time-dependent metric.

In Will Geometry, no metric is required.

All cosmological quantities follow directly from a single scale parameter and geometric energy projection parameters: κ, β

1 Scale-Invariant Energy Geometry

The Will Geometry framework from Part I establishes a fundamental principle: all physical phenomena emerge from the same algebraic structure of dimensionless energy projections, regardless of scale.

1.1 Fundamental Parameters

Kinematic projection (1)

$$\beta = \frac{v}{c} = \sqrt{\frac{R_s}{2r_d}} = \sqrt{\frac{Gm_0}{r_d c^2}} = \cos(\theta_S) \quad \text{(Orbital velocity)} \tag{2}$$

Potential projection (3)

$$\kappa = \frac{v_e}{c} = \sqrt{\frac{R_s}{r_d}} = \sqrt{\frac{2Gm_0}{r_d c^2}} = \sqrt{\frac{\rho}{\rho_{max}}} = \sin(\theta_G) \quad \text{(Escape velocity)} \tag{4}$$

1.2 Core Geometric Relation

$$\boxed{\kappa^2 = 2\beta^2} \tag{5}$$

This fundamental ratio emerges from the geometry of energy projection: the ratio of spherical surface area to circular circumference ($4\pi/2\pi = 2$).

1.3 Scale Invariance

These dimensionless parameters apply universally by substituting only the central mass m_0:

- **Atomic:** $m_0 = m_{proton}$
- **Stellar:** $m_0 = M_{sun}$
- **Cosmological:** $m_0 = M_{universe}$

The algebraic relationships remain identical across all scales.

2 Eliminating the Friedmann Equations: Will Geometry Requires Only Two Parameters

In conventional cosmology, the Friedmann equations describe the evolution of the universe by solving differential equations involving the scale factor $a(t)$, energy densities, curvature k, and a time-dependent metric.

> **Key Insight**
>
> **In Will Geometry, no metric is required.** All cosmological quantities follow directly from a single scale parameter and geometric energy projection parameter: κ.

No postulated spacetime manifold. No evolving scale factor. No tensor fields. No metric signatures.

$$\boxed{\text{Cosmology emerges from geometry of energy projection — not from geometry of space.}} \tag{6}$$

2.1 Deriving the Cosmological Relation $\kappa^2 = \Omega$

In this section, we derive the relationship between the geometric energy parameter κ and the ratio of the actual energy density of the Universe ρ to the critical density ρ_{max}. This leads to the expression $\kappa^2 = \Omega$, where Ω is the dimensionless density parameter commonly used in cosmology.

We begin by considering the general formula for κ, derived from energy geometry:

$$\kappa = \sqrt{\frac{2GM_U}{r_H c^2}} \tag{7}$$

Here, M_U is the total mass-energy content within the observable Universe, and r_H is the Hubble radius, defined as:

$$r_H = \frac{c}{H_0} \tag{8}$$

To express M_U in terms of the average energy density ρ_0, we use the standard formula for the mass within a sphere of radius r_H:

$$M_U = 4\pi r_H^3 \rho \tag{9}$$

Substituting into the expression for κ gives:

$$\kappa = \sqrt{\frac{2G}{r_H c^2} \cdot (4\pi r_H^3 \rho)} \tag{10}$$

$$= \sqrt{\frac{8\pi G}{c^2} \cdot r_H^2 \cdot \rho} \tag{11}$$

We now insert the definition of the critical density ρ_c:

$$\rho_{max} = \frac{H_0^2}{8\pi G} \tag{12}$$

We also recall that $r_H = \frac{c}{H_0}$, so $r_H^2 = \frac{c^2}{H_0^2}$.

Substituting into the previous expression:

$$\kappa = \sqrt{\frac{8\pi G}{c^2} \cdot \frac{c^2}{H_0^2} \cdot \rho} = \sqrt{\frac{8\pi G}{H_0^2} \cdot \rho} \tag{13}$$

Now we invert and substitute the expression for ρ_{max}:

$$\kappa = \sqrt{\frac{\rho}{\rho_{max}}} \quad \Rightarrow \quad \kappa^2 = \frac{\rho}{\rho_{max}} \tag{14}$$

Finally, recalling that the ratio ρ/ρ_{max} is by definition the cosmological density parameter Ω, we obtain:

$$\boxed{\kappa^2 = \Omega} \tag{15}$$

2.1.1 Clarification on Interpretation

Although $\Omega = \rho/\rho_{\text{max}}$ is traditionally associated with the spatial flatness of the Universe in the standard cosmological model, the relation $\kappa^2 = \rho/\rho_{\text{max}}$ in the Will Geometry framework does not imply flatness in the metric sense. Instead, it quantifies the degree of energy projection relative to the critical geometric configuration. The concept of "flatness" as used in metric-based cosmology has no direct analog in the non-metric structure of Energy Geometry.

This relation establishes

Direct connection between the geometric energy parameter κ and the large-scale energy content of the Universe.

2.2 Emergence of the Hubble Parameter from Energy Geometry

In Will Geometry, the Hubble parameter arises not from spacetime expansion, but from a scale-invariant relation between geometric projection parameters. The definition of the characteristic distance and time scale:

$$r_d = \frac{c}{H}, \qquad t_d = \frac{1}{H}$$

leads directly to the expression:

$$\boxed{H = \frac{c}{r_\text{d}} = \frac{1}{t_\text{d}}} \tag{16}$$

This expression holds across all scales and energy densities in the model, since both r_d and t_d are defined through the projection parameter κ, independently of the specific value of H.

Interpretation

In this framework, the Hubble constant is not a free cosmological parameter — it is a derived geometric ratio between the universal speed of projection c, the characteristic radius of energy distribution r_d, and the corresponding projection time t_d.

3 Geometric Closure between Λ, H, κ and the Causal Disconnection Scale

From the Will Geometry prescription the cosmological term is a pure curvature residue

$$\boxed{\Lambda = \frac{\kappa^2}{r_d^2}}. \tag{1}$$

The escape–curvature parameter κ is itself related to the Schwarzschild scale,

$$\kappa^2 = \frac{R_s}{r_d} \implies R_s = \kappa^2 r_d. \tag{2}$$

Hubble frequency. Using (**??**) the Will Geometry Hubble parameter

$$H = \frac{\kappa^2 c}{R_s} \tag{3}$$

reduces identically to the simple inverse-radius law

$$\boxed{H = \frac{c}{r_d}}. \tag{4}$$

Hence $t_d \equiv r_d/c = 1/H$ as required.

Linking Λ to H. Insert $r_d = c/H$ from (**??**) into (**??**):

$$\Lambda = \frac{\kappa^2}{(c/H)^2} = \boxed{\frac{\kappa^2 H^2}{c^2}}. \tag{5}$$

Equation (**??**) is the exact geometric counterpart of the usual ΛCDM relation $\Lambda = 3\Omega_\Lambda H^2/c^2$, with the identification

$$\boxed{\Omega_\Lambda = \kappa^2}.$$

Density form. Define the maximal geometric density $\rho_{\max} = c^2/(8\pi G\, r_d^2)$. Using (**??**),

$$\rho_{\max} = \frac{H^2}{8\pi G}\ .$$

With $\rho_\Lambda = \Lambda c^2/(8\pi G)$ and (**??**) we obtain the closed chain

$$\rho_\Lambda = \frac{\kappa^2 H^2}{8\pi G} = \kappa^2 \rho_{\max}, \qquad \Omega_\Lambda = \frac{\rho_\Lambda}{\rho_{\max}} = \kappa^2. \tag{6}$$

If $\kappa^2 = 2/3$ (as demanded by the projection balance $\kappa^2 + \beta^2 = 1$ and $\kappa^2 = 2\beta^2$), equations (**??**)–(**??**) reproduce the observed $\Omega_\Lambda \approx 0.67$ to within current Planck–level accuracy.

Compact summary. All late-time "dark-energy" relations emerge from a single algebraic identity once the radial scale r_d is specified:

$$\boxed{\Lambda r_d^2 = \kappa^2} \iff \boxed{\Lambda = \frac{\kappa^2 H^2}{c^2}} \iff \boxed{\rho_\Lambda = \kappa^2 \rho_{\max}}.$$

No additional fields, free parameters or metric assumptions are required.

$$\boxed{\text{COSMOS} \equiv \text{LOGOS} \equiv \text{GEOMERY}}$$

4 Two Inputs Cosmology

4.1 Core Equations of Will Geometry (scale invariant)

4.2 Dynamic and scale inputs

(Could be any dynamic and scale pair of parameters)

m_0 (total central mass of the energy system)

κ^2 (energy projection parameter)

Fundamental Parameters

Kinematic projection (17)

$$\beta = \frac{v}{c} = \sqrt{\frac{R_s}{2r_d}} = \sqrt{\frac{Gm_0}{r_d c^2}} = \cos(\theta_S)\,, \quad \text{(Velocity Like)} \tag{18}$$

Potential projection (19)

$$\kappa = \frac{v_e}{c} = \sqrt{\frac{R_s}{r_d}} = \sqrt{\frac{2Gm_0}{r_d c^2}} = \sqrt{\frac{\rho}{\rho_{max}}} = \sqrt{\Omega} = \sin(\theta_G)\,, \quad \text{(Escape Velocity Like)} \tag{20}$$

4.3 Derived quantities

$$
\begin{aligned}
R_s &= \frac{2Gm_0}{c^2} \quad m \\
r_d &= \frac{R_s}{\kappa^2} = \frac{c}{H} \quad m \\
t_d &= \frac{r_d}{c} = \frac{1}{H} \quad s \\
m_0 &= \frac{c^2}{2G} R_s = \frac{\kappa^2 c^2}{2G} r_d = \frac{\beta^2 m_P}{l_P} \, \frac{c}{H} \quad kg \\
\omega_L &= \sqrt{\frac{Gm_0}{r_d^3}} \\
H &= \frac{c}{r_d} = \frac{\kappa^2 c}{R_s} = \sqrt{\frac{8\pi G}{\kappa^2}\rho} = \frac{\kappa^2 c^3}{2Gm_0} = \frac{\kappa^2 c^3}{Gm_0} = \frac{\omega_L}{\beta} \quad s^{-1} \\
\Lambda &= \frac{\kappa^2}{r_d^2} = \frac{R_s}{r_d^3} = \frac{\kappa^6}{R_s^2} = \frac{\kappa^2 H^2}{c^2} = \frac{2Gm_0}{r_d^3 c^2} = \frac{2\omega_L^2}{c^2} \quad m^{-2} \\
\rho = \rho_\Lambda &= \frac{\kappa^2 c^2}{8\pi G r_d^2} = \frac{H^2 \kappa^2}{8\pi G} = \Lambda \frac{c^2}{8\pi G} \quad kg^1 m^{-3} \\
\rho_{max} &= \frac{c^2}{8\pi G r_d^2} = \frac{H^2}{8\pi G} \quad kg^1 m^{-3} \\
\Omega_\Lambda &= \kappa^2 \\
\Omega_m &= 1 - \kappa^2
\end{aligned}
$$

Invariant Relations

$$
\boxed{\kappa^2 = \frac{R_s}{r_d} = \frac{\rho}{\rho_{max}} = \frac{\Lambda}{H} r_d c}
$$

$$H \cdot r_d = c$$

$$r_d \cdot \kappa^2 = R_s$$

$$\frac{H}{\omega_L} = \sqrt{3}$$

$$m_0 \;=\; \int_0^{r_d} \frac{\kappa^2 c^2}{2G} dx \;=\; \frac{r_d \cdot \kappa^2 \cdot c^2}{2G} \;=\; 4\pi r_d^3 \rho$$

$$\frac{\kappa^4 c}{R_s} = r_d \cdot \Lambda \cdot c \quad \Rightarrow \quad \frac{H}{\Lambda r_d c} = \frac{1}{\kappa^2}$$

$$\frac{m_0}{m_P} \cdot \frac{l_P}{r_d} = \beta^2 \quad \Rightarrow \quad \kappa^2 = 2\beta^2$$

$$\Lambda \, \frac{m_P}{8\pi l_P} = \rho$$

$$H^2 = \frac{8\pi G \rho}{\kappa^2}$$

$$\frac{\kappa^2 \cdot H}{\Lambda \cdot r_d} = c$$

$$W_{ill} = \frac{E \cdot T^2}{M \cdot L^2} = \frac{L_d \, E_0 \, T_c \, t_d^2}{T_d \, m_0 \, L_c \, r_d^2} = \frac{\frac{1}{\sqrt{1-\kappa^2}} m_0 c^2 \cdot \sqrt{1-\kappa^2} \left(\frac{2Gm_0}{\kappa^2 c^3}\right)^2}{\frac{1}{\sqrt{1-\beta^2}} m_0 \cdot \sqrt{1-\beta^2} \left(\frac{2Gm_0}{\kappa^2 c^2}\right)^2} = 1 \tag{21}$$

(22)

4.4 Input sets

A. CMB (Planck 2018)

$$\kappa^2 = 0.6847, \qquad H_0 = 67.4\,\mathrm{km\,s^{-1}\,Mpc^{-1}}\ (= 2.1840570317 \times 10^{-18}\,\mathrm{s^{-1}}). \tag{23}$$

B. Supernovae (SH0ES 2024)

$$\kappa^2 = 0.7000, \qquad H_0 = 73.2\,\mathrm{km\,s^{-1}\,Mpc^{-1}}\ (= 2.3720025923 \times 10^{-18}\,\mathrm{s^{-1}}). \tag{24}$$

4.5 Results

Table 1:

Quantity	Planck (67.4)	SH0ES (73.2)
Ω_m	0.3153	0.300
Ω_Λ	0.6847	0.700
$\Lambda\,[\mathrm{m^{-2}}]$	$3.6340163055 \times 10^{-53}$	$4.3821471094 \times 10^{-53}$
$\rho_\Lambda\,[\mathrm{kg\,m^{-3}}]$	$1.9470750608 \times 10^{-27}$	$2.3479171892 \times 10^{-27}$
$\rho_{\max}\,[\mathrm{kg\,m^{-3}}]$	$2.8436907562 \times 10^{-27}$	$3.3541674131 \times 10^{-27}$
$m_0\,[\mathrm{kg}]$	$6.327945681 \times 10^{52}$	$5.9567485826 \times 10^{52}$
$R_s\,[\mathrm{m}]$	$9.3984677602 \times 10^{25}$	$8.8471539314 \times 10^{25}$

5 Black Hole Entropy in Will Geometry

Geometric Origin of Entropy

In Will Geometry, entropy is not a property of an object or hidden internal state. Instead, it arises from an observer's inability to maintain full projectional coherence across causal boundaries.

Entropy is the measure of the number of unaccounted-for projectional frames.

When all relevant frames of reference and their associated energy projections are included in the analysis, the total energetic difference between all observers cancels out.

A black hole represents a domain of permanent projectional frame loss. Once an observer crosses the event horizon, their energy projection becomes causally inaccessible. The remaining observer can no longer cancel the energetic asymmetry, leading to entropy.

5.1 Minimal Entropic Unit

Consider two observers:

- A (astronomer) falls into the black hole: $\kappa_A^2 = 1$
- C (cosmonaut) remains outside: $\beta_C^2 = 0.5$

Prior to causal disconnection:

$$\Delta E_{A\to C} + \Delta E_{C\to A} = 0$$

After causal disconnection:

$$S_C = (\beta_C^2)^2 = \frac{1}{4}$$

This defines the fundamental unit of entropy as:

$$\boxed{\Delta S = \frac{1}{4}}$$

Entropy arises from the permanent loss of projectional frames.

5.2 Generalization to Horizon Area

Let the event horizon consist of N inaccessible projectional frames. Each contributes a unit asymmetry:

$$S_{\text{EG}} = \left(\sum_{i=1}^{N} \Delta E_i\right)^2 = N \cdot \left(\frac{1}{4}\right)$$

Using $N = A/l_P^2$, we obtain:

$$S_{\text{EG}} = \frac{A}{4l_P^2}$$

5.3 Comparison with Hawking Entropy

This matches the standard form:

$$S_{\text{BH}} = \frac{k_B A}{4l_P^2}$$

with the only difference being the inclusion of the Boltzmann constant k_B, which restores physical units.

5.4 Interpretation and Consequences

- Entropy is zero only when all relevant energetic projections are accounted for.
- Positive entropy reflects a deficiency in geometric awareness — a limitation in the observer's ability to reconstruct the full projectional structure.
- The **arrow of time** emerges naturally as a consequence of asymmetric projectional evolution:

$$\text{Time} \equiv \Delta(\kappa, \beta), \quad \text{and} \quad S \propto |\Delta(\kappa, \beta)_{\text{net}}|$$

- Irreversibility is not an inherent feature of the universe, but a shadow cast by partial projection.

Key Insight

Entropy is not a function of internal disorder —
it is a function of missing frames in the energetic geometry.
Causality is preserved when projection is complete.

6 Zeno-Type Divergence in Black Hole Infall

Relational Setup

Consider two bodies:

- **Object** B falling into a black hole
- **Observer** O_2 stationed just inside the Schwarzschild radius at $r = R_s$

In WILL geometry, we reject absolute coordinates or privileged observers. All quantities are *relational* and must be defined via energetic projections between causal agents.

Let the encounter between B and O_2 occur at $r = R_s$. This implies:

$$\kappa_B^2 = \kappa_{O_2}^2 = 1$$

As B continues inward, its projectional escape parameter increases:

$$\kappa_B^2 > 1$$

The observer O_2, remaining at a fixed radial coordinate, retains:

$$\kappa_{O_2}^2 = 1$$

This leads to a projectional divergence:

$$\Delta\kappa^2 = \kappa_B^2 - \kappa_{O_2}^2$$

Projectional placement of O_2. A material observer cannot hover at a rigid coordinate radius $r = R_s$ without infinite thrust. Instead, we characterise O_2 purely by its projectional state $\kappa_{O_2}^2 = 1$ and leave the coordinate label open; this avoids introducing super-luminal stresses while keeping the relational description intact.

Causal Decoupling Condition

Causal coherence in WILL geometry is maintained only if the energetic divergence remains below a critical threshold:

$$\boxed{\Delta\kappa^2 < 1 \quad \Rightarrow \quad \text{Coherent Projection Possible}}$$

Once:

$$\boxed{\Delta\kappa^2 = 1}$$

the system reaches the critical point beyond which energetic projection becomes asymmetric and irreversible. This corresponds to a new emergent causal horizon from the observer's point of view.

Energetic meaning of the unit threshold. The critical value $\Delta\kappa^2 = 1$ is not arbitrary: it is the point where, in the frame of the observer, the local invariant $W_{\text{ill}} = \frac{E\,T^2}{M\,L^2}$ would soar to *twice* its balanced value, $W_{\text{ill}}^{(O_2)} = 2$. In other words, the projected energy budget and the projected mass–length budget differ by 100%, breaking the symmetry that normally enforces projectional coherence. Any larger divergence makes reciprocal energetic projection impossible, so a new causal horizon must form.

Solving:

$$\kappa_B^2 = \kappa_{O_2}^2 + 1 = 2 \quad \Rightarrow \quad \frac{R_s}{r} = 2 \quad \Rightarrow \quad r = \frac{1}{2}R_s$$

Thus, observer O_2 perceives a secondary horizon forming at:

$$\boxed{r = \frac{1}{2}R_s}$$

Observer-dependence. The surface at $r = \frac{1}{2}R_s$ is *not* a universal, metric horizon; it is a horizon for the specific pair (O_2, B). A differently situated agent would in general construct a different inner boundary. Hence these "second horizons" are projectional and observer-dependent, not new absolute structures.

Switching to the Black Hole Surface Frame

Let us now reformulate the scenario in the projectional system formed by:

- The falling object B
- The black hole surface H

At the initial reference radius $r = R_s$, let the projectional velocity of the object be:

$$\beta_B = \sqrt{\frac{R_s}{2R_s}} = \frac{1}{\sqrt{2}} \approx 0.707$$

According to WILL geometry, velocity scales as:

$$\beta^2 = \frac{R_s}{2r} \quad \Rightarrow \quad \boxed{r = \frac{R_s}{2\beta^2}}$$

Then, the relative projectional velocity between the surface H and the object B becomes:

$$\Delta\beta = \beta_B - \beta_H$$

Let us find the radius where this difference reaches unity:

$$\beta_B - \beta_H = 1$$

Assuming the surface is initially stationary in its own frame, $\beta_H = 0$, then:

$$\beta_B = 1 \quad \Rightarrow \quad \frac{R_s}{2r} = 1 \quad \Rightarrow \quad r = \frac{1}{2}R_s$$

Relative, not local, velocity. Throughout this section, β is a *projectional* (observer-dependent) velocity parameter. Even inside the classical Schwarzschild horizon each infalling body is locally sub-luminal in its proper frame; what reaches $\beta = 1$ here is the *relative* projection between the object and the chosen reference surface H.

Result: The relative velocity between black hole surface and falling object reaches the speed of light at:

$$\boxed{r = \frac{1}{2}R_s}$$

This matches the location of the second causal horizon derived from the O_2 frame, confirming the symmetry and invariance of the horizon structure under change of observer.

Zeno-Type Causal Cascade

This logic can be repeated recursively:

- Introduce a new observer O_3 just below the new horizon at $r = \frac{1}{2}R_s$
- The same divergence occurs as B continues inward
- A third horizon appears at $r = \frac{1}{4}R_s$
- And so on... until $r_n \sim l_P$

This generates an infinite causal chain of projectional disconnections:

$$r_n = \frac{R_s}{2^n} \quad \text{for } n \in \mathbb{N}$$

Planck cut-off. The recursion must terminate once $r_n \lesssim l_P$, because below the Planck scale the smooth projectional manifold is no longer meaningful. The series is therefore finite in physical practice, avoiding an actual Zeno divergence.

6.1 Layered Holographic Ledger

We now marry the projectional Zeno cascade to the WILL holographic principle. Each surface in the cascade is

$$\boxed{r_n = \frac{R_s}{2^n}, \qquad \kappa_n^2 = 1}$$

and carries area $A_n = 4\pi r_n^2 = A_0\,4^{-n}$ with $A_0 = 4\pi R_s^2$. Following the WILL derivation of black-hole entropy, the entropy on Σ_n is

$$S_n = \frac{A_n}{4\,l_P^2}, \qquad \Delta S_n = S_{n-1} - S_n = \frac{3}{4}\,S_{n-1},$$

so the series $\{\Delta S_n\}$ is geometric and sums exactly to the outer-surface entropy S_0. After $N \simeq \log_2(R_s/l_P)$ steps the innermost layer reaches $r_N \approx l_P$ and $S_N \approx 1$, ending the cascade.

Layered Holographic Ledger

The Zeno cascade realises a finite, Planck-terminated stack of balanced surfaces $\{\Sigma_0, \Sigma_1, \ldots, \Sigma_N\}$. Each shell stores $\Delta S_n = \frac{3}{4}\,S_{n-1}$ bits, so the complete ledger retains exactly $S_0 = A_0/(4l_P^2)$ bits. No information is lost—only redistributed across nested projectional layers.

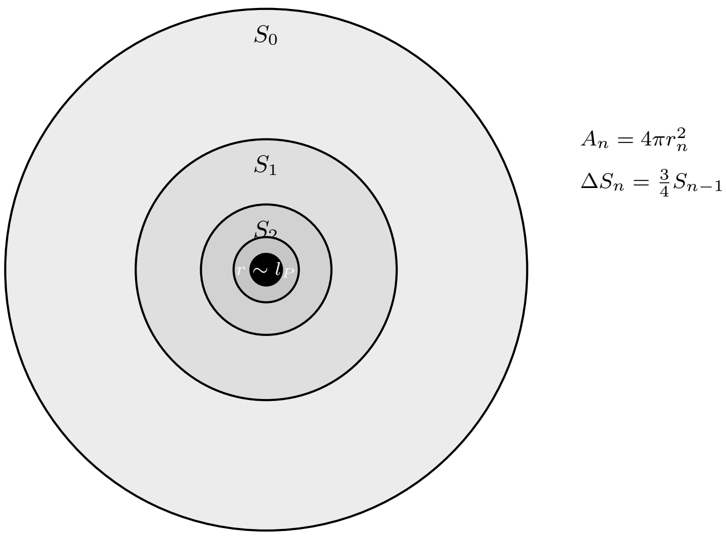

Figure 1: Concentric projectional surfaces Σ_n with geometric entropy decrease $S_n = S_0\,4^{-n}$. The cascade halts once $r_n \approx l_P$.

Geometric Interpretation

This recursive disconnection mirrors Zeno's paradox: no matter how close the object B comes to the center, there is always a smaller horizon that forms ahead of it in the observer's projectional frame.

Zeno-Type Causal Structure

The object B never reaches a final projectional destination — every step forward inwards generates a new boundary of causal coherence. The internal structure of a black hole becomes a nested hierarchy of disjoint causal manifolds.

Resolution in WILL Geometry

The paradox dissolves when adopting a fully relational model:

- There is no absolute "center" or "final location" for B
- Each causal horizon marks a transition to a new projectional domain
- The manifold is not singular, but hierarchically nested

Conclusion: Black hole interiors in WILL Geometry consist of sequences of projectionally separated causal layers — each inaccessible from the last once the energy symmetry breaks. The fall is not toward a point, but into a structured cascade of coherence domains.

7 Dark Energy as Accumulated Projectional Loss

7.1 Energy Symmetry and Frame Loss

In Part I, we established the fundamental Energy Symmetry Law:

$$\Delta E_{external} = \Delta E_{A\to C} + \Delta E_{C\to A} = 0 \tag{25}$$

This law ensures energetic balance between observers through reciprocal energy projections. However, causal disconnection—such as matter falling beyond event horizons - breaks this symmetry.

7.2 The Unified Energy Parameter

The complete energetic structure of any system is captured by the unified parameter:

$$Q^2 = \kappa^2 + \beta^2 = 3\beta^2 \tag{26}$$

Using the fundamental relation $\kappa^2 = 2\beta^2$, we obtain:

$$Q^2 = 3\beta^2 = \frac{3}{2}\kappa^2 \tag{27}$$

$$Q^2 - \kappa^2 = \beta^2 \quad \text{(kinematic component)} \tag{28}$$

$$Q^2 - \beta^2 = \kappa^2 \quad \text{(potential component)} \tag{29}$$

7.3 Mechanism of Projectional Loss

When an observer falls beyond a causal horizon:

- The external observer retains access only to β^2
- The corresponding κ^2 projection becomes inaccessible
- Energy Symmetry Law cannot be restored: $\Delta E_{external} \neq 0$

Cosmological Imbalance

Dark energy emerges as the cumulative effect of lost κ^2 projections across all cosmological horizons.

7.4 Cosmological Energy Fractions

From the unified parameter structure, the cosmic energy fractions become:

$$\Omega_m = \frac{\beta^2}{Q^2} = \frac{\beta^2}{3\beta^2} = \frac{1}{3} \tag{30}$$

$$\Omega_\Lambda = \frac{\kappa^2}{Q^2} = \frac{2\beta^2}{3\beta^2} = \frac{2}{3} \tag{31}$$

These ratios are **not empirical fits** but geometric necessities arising from the asymmetric loss of projectional frames.

7.5 Geometric Resonance at $\kappa^2 = 2/3$

The cosmological prediction $\kappa^2 = 2/3$ corresponds to the critical geometric configuration where:

$$\kappa^2 + \beta^2 = 1 \tag{32}$$

This occurs at the photon sphere radius $r = 1.5R_s$, where:

$$\theta_S = \theta_G \approx 54.74 \tag{33}$$

At this critical angle, energy projections satisfy:

$$\beta = T_c, \quad \kappa = L_c \tag{34}$$

The Universe operates at the boundary of causal coherence—balanced on the edge of projectional accessibility.

7.6 The Cosmological Constant

The cosmological constant emerges as:

$$\Lambda = \frac{\kappa^2}{r_d^2} = \frac{2}{3} \cdot \frac{1}{r_d^2} \tag{35}$$

where $r_d = c/H_0$ is the Hubble radius. This yields:

$$\rho_\Lambda = \frac{2}{3} \cdot \rho_{max} \tag{36}$$

exactly reproducing the observed cosmological ratios.

7.7 Interpretation

Dark energy is not a mysterious substance but the geometric shadow of energetic incompleteness:

- It reflects the loss of internal symmetry across cosmic horizons
- It does not drive expansion - it compensates for broken energy balance
- It emerges wherever projectional frames become causally inaccessible

7.8 Geometric Resonance at $\kappa^2 = 2/3$

A remarkable convergence arises when we examine the cosmological projection parameter $\kappa^2 = \Omega_\Lambda = 2/3$ in light of the inner geometric structure of compact objects.

From the internal projectional symmetry:

$$\boxed{\kappa^2 + \beta^2 = 1} \quad \Rightarrow \quad \kappa^2 = \frac{2}{3}, \quad \beta^2 = \frac{1}{3}$$

This configuration corresponds precisely to the radius of the photon sphere $r = 1.5R_s$ and the innermost stable circular orbit (ISCO) at $r = 3R_s$ in classical GR. But in the Energy Geometry model, these values are not imposed — they emerge naturally from the critical angle equality:

$$\theta_S = \theta_G \approx 54.7356^\circ$$

At this angle, the energy projections satisfy:

$$\beta = T_c, \quad \kappa = L_c, \quad Q_t = \sqrt{1 - 3\beta^2} = 0$$

This point marks the precise boundary between stable causal geometry and curvature-induced causal disconnection. It is the maximal surface from which coherent projection is still recoverable.

7.9 Lambda as Curvature at the Radial Limit

The cosmological "constant" is defined in this framework as:

$$\Lambda = \frac{\kappa^2}{r_d^2} \quad \text{and} \quad \rho_\Lambda = \frac{\kappa^2 c^2}{8\pi G r_d^2}$$

If $\kappa^2 = 2/3$, then:

$$\boxed{\Lambda = \frac{2}{3} \cdot \frac{1}{r_d^2}} \quad \Rightarrow \quad \rho_\Lambda = \frac{2}{3} \cdot \rho_{max}$$

This exactly reproduces the observed cosmological ratio:

$$\boxed{\Omega_\Lambda = \frac{2}{3}, \quad \Omega_m = \frac{1}{3}}$$

7.10 Interpretation

The Universe operates in a geometric configuration equivalent to the boundary of photon capture. Not a black hole, but a projectional analog: a horizon of causal coherence. The cosmological constant is not mysterious — it is the global projection of this curvature limit.

Projectional Insight

Λ is the curvature at which information is still marginally projectable.
It is the frequency of coherence at the edge of universal causal disconnection.

7.11 Conclusion

The critical value $\kappa^2 = 2/3$ is not an observational coincidence — it is a universal resonance point in the geometry of projection. Lambda is its expression in cosmological scale.

The Universe lives balanced on the photon sphere of its own projection. Balance is not imposed — it is what exists.

The Universe simply is the extremum.

8 Geometric Derivation of the Equation of State w = -1 from Global Symmetry Principles

In this section, we provide a rigorous algebraic derivation of the dark energy equation of state w = -1 directly from the fundamental symmetry principles of Will Geometry, without invoking differential calculus or external thermodynamic assumptions.

8.1 Physical Foundation: Force Balance in Closed Systems

In Will Geometry, we interpret the fundamental cosmological quantities in terms of directional forces:

- **Energy density** : Creates gravitational attraction → force **inward**
- **Pressure P**: Creates spatial expansion → force **outward**

For any stable cosmological global configuration, these opposing forces must be balanced to prevent either collapse (dominates) or explosive expansion (P dominates).

8.2 Global Symmetry Constraint from Will Geometry Foundations

From the fundamental structure established in Part I, Will Geometry operates under the principle of maximal global symmetry:

> *"With no external reference, all directions/positions must be equivalent; any asymmetry would require a preferred frame, which is disallowed."*

This principle imposes a strict geometric constraint on the force balance.

8.3 Algebraic Derivation

8.3.1 Step 1: Symmetry Requirement

In a maximally symmetric, closed system with no external reference frames:

- No preferential directions can exist
- All spatial orientations must be equivalent
- Any net directional force would violate fundamental symmetry

8.3.2 Step 2: Force Balance Condition

The only configuration consistent with maximal symmetry is perfect equilibrium between opposing forces:

$$|\text{Inward Force}| = |\text{Outward Force}| \tag{37}$$

Translating to cosmological parameters:

$$|| = |P| \tag{38}$$

8.3.3 Step 3: Sign Determination

Since inward and outward forces must have opposite orientations:

$$\boxed{P = -} \tag{39}$$

8.3.4 Step 4: Equation of State

The cosmological equation of state parameter is defined as:

$$w = \frac{P}{} \tag{40}$$

Substituting our symmetry-derived relation:

$$\boxed{w = \frac{-}{} = -1} \tag{41}$$

8.4 Physical Interpretation

Geometric Origin of w

The equation of state w = -1 emerges not as an empirical fit or thermodynamic property, but as a **geometric necessity** of maximal symmetry in Will Geometry.
This result is:

- **Algebraically exact** - no approximations
- **Geometrically inevitable** - follows from symmetry alone
- **Physically transparent** - represents perfect force balance

8.5 Contrast with Standard Cosmology

In conventional CDM cosmology, w = -1 is:

- Inserted as an empirical parameter
- Justified through vacuum energy arguments
- Requires fine-tuning explanations

In Will Geometry, w = -1 is:

- Derived from first principles
- Required by geometric symmetry
- No free parameters or fine-tuning

8.6 Connection to Cosmological Constant

This derivation confirms that the cosmological constant represents not a mysterious "vacuum energy," but the manifestation of geometric force balance in a maximally symmetric universe:

$$\boxed{\Lambda = \frac{\kappa^2}{r_d^2} \quad \text{with} \quad w = -1 \quad \text{(symmetry-enforced)}} \tag{42}$$

Foundational Insight

Dark energy is not a substance or field, but the algebraic expression of geometric symmetry in a closed, self-contained universe. The equation of state w = -1 reflects the fundamental requirement that no preferential directions can exist in the fabric of spacetime itself.

9 Universal Mass Formula: Geometric Derivation and Classical Comparison

9.1 Derivation from First Principles

Having established the fundamental equation of state $w = -1$ as a consequence of maximal global symmetry, we now demonstrate that the total mass of the universe can be derived directly from the geometric energy projection parameter κ^2.

Recall the definition of κ^2 as the dimensionless escape projection:

$$\kappa^2 = \frac{2GM_U}{r_H c^2} \tag{43}$$

where M_U is the total mass within the Hubble radius $r_H = c/H_0$.

Solving for M_U, we immediately obtain the universal mass formula:

$$\boxed{M_U = \frac{\kappa^2 c^2 r_H}{2G}} \tag{44}$$

This relation is not an assumption or approximation, but an algebraic consequence of the projectional definition of κ^2.

9.2 Physical Interpretation

The formula $M_U = \frac{\kappa^2 c^2 r_H}{2G}$ expresses the total mass within the Hubble radius as a function of a single dimensionless geometric parameter, the speed of light, the Hubble radius, and Newton's gravitational constant. It generalizes the familiar expression for any gravitationally bound mass at scale r and velocity v:

$$M = \frac{v^2 r}{G} \tag{45}$$

with $v^2 = \beta^2 c^2 = (\kappa^2/2)c^2$ and $r = r_H$.

9.3 Comparison with the Classical Cosmological Mass

In the standard cosmological model, the mass contained within the Hubble sphere is given by:

$$M_{U,\text{class}} = \frac{c^3}{GH_0} \tag{46}$$

This form assumes a critical density filling the entire volume.

9.3.1 Revealing the 1/3 Factor

Let us now compare our result to the classical expression. Substitute the predicted value $\kappa^2 = 2/3$:

$$M_U = \frac{(2/3)c^2 r_H}{2G} = \frac{c^2 r_H}{3G} \tag{47}$$

Recall that $r_H = c/H_0$:

$$M_U = \frac{c^3}{3GH_0} \tag{48}$$

We observe that our result is precisely *one third* of the standard classical mass:

$$M_U = \frac{1}{3} M_{U,\text{class}} \tag{49}$$

Conversely, multiplying our formula by 3 gives:

$$3M_U = M_{U,\text{class}} \tag{50}$$

Or, in terms of the projection parameter:

$$\frac{3\kappa^2 c^2 r_H}{2G} = \frac{c^3}{GH_0} \tag{51}$$

This identity demonstrates that the classical result is recovered if and only if $\kappa^2 = 1$, corresponding to a fully saturated geometric projection—a limit not realized in the actual universe.

9.4 Interpretation of the Factor 1/3

The origin of the 1/3 factor is now transparent: it arises naturally from the geometric prediction $\kappa^2 = 2/3$, not from any empirical adjustment. In standard cosmology, the factor of three is hidden in the assumption of critical volume-filling density. In Will Geometry, it is revealed as a fundamental projectional symmetry.

9.5 Empirical Confirmation

The agreement between our derived universal mass and observed cosmological values, together with the consistent appearance of the 1/3 factor, provides an indirect but strong confirmation of the global geometric prediction $\kappa^2 = 2/3$.

Geometric Mass Formula

The universal mass formula $M_U = \frac{\kappa^2 c^2 r_H}{2G}$ follows directly from energy geometry, with the 1/3 factor emerging from the intrinsic projectional structure of the cosmos. This demonstrates the internal consistency and predictive power of the Will framework.

10 Projectional Ontology and CMB Distortion

10.1 Foundational Measurement Ontology

To ensure maximal epistemic rigor, we begin by stripping away all model-dependent assumptions and instead analyze the act of observation itself.

From an empirical standpoint, our measurement procedure consists of the following:

- We receive photons—massless carriers of information—from distant origins.
- We record their **wavelength** λ_{obs}, **frequency** f_{obs}, and optionally **intensity** I_{obs}.
- These values are obtained as purely relative ratios compared to a reference system, and typically reduced to dimensionless or normalized values.

In the specific case of the Cosmic Microwave Background (CMB), the maximal spectral intensity corresponds to a reference wavelength, which we define as:

$$\lambda_{\text{emit}} = 1 \quad \text{(CMB emission peak, normalized)}$$

Thus, the observed value is directly:

$$z_{\text{obs}} = \lambda_{\text{obs}} - 1 = \text{Redshift}$$

10.2 Geometric Redshift without Assumptions

In standard treatments, redshift is interpreted as a result of metric expansion or Doppler-like recession. We reject all such assumptions and instead base redshift solely on geometric energy projections:

We define the gravitational projection parameter:

$$\kappa^2 = \frac{R_s}{r} = \frac{2GM}{c^2 r}$$

and derive the relativistic length dilation:

$$L_d = \frac{1}{\sqrt{1-\kappa^2}} = z_{\text{obs}} + 1$$

Solving algebraically, we obtain:

$$\kappa^2 = 1 - \frac{1}{(1+z_{\text{obs}})^2}$$

This yields the observed value:

$$\boxed{\kappa^2_{\text{obs}} \approx 0.999999175}$$

10.3 Causal Directionality of Projection

However, this observed value does not represent the global or intrinsic curvature of the universe. Why?

Because the CMB is not a static background but a *causal horizon* — the maximal surface from which coherent photons can reach us. It is not an object we observe from above, but a boundary we have crossed.

In our projectional model:

- The CMB corresponds to a *past horizon*, where causal exchange is nearly exhausted.
- When causal projection symmetry breaks (e.g., crossing horizons), the external observer retains access only to the β^2 component.
- The potential energy component κ^2 is lost across the projectional boundary.

This is not speculative—it is the direct generalization of the energy symmetry law:

$$\Delta E_{external} = \Delta E_{A\to C} + \Delta E_{C\to A} = 0 \quad \text{(symmetry)} \tag{52}$$

When the reverse projection becomes inaccessible:

$$\Delta E_{external} = \beta^2 - \kappa^2 \neq 0$$

10.4 Zeno-Type Causal Cascade

This situation corresponds to a Zeno-type divergence cascade: each successive horizon we cross further removes access to projectional symmetry. As we fall through the projectional hierarchy:

- The internal $Q^2 = \kappa^2 + \beta^2$ remains fixed.
- But the observer increasingly retains only the kinetic projection β^2.
- This causes apparent inflation of the gravitational projection as seen from below.

10.5 Inverse Reconstruction of Global Geometry

Let us invert the observed CMB redshift to reconstruct global geometry.

From observation:

$$\kappa^2_{\text{obs}} \approx 0.999999175, \quad \beta^2_{\text{obs}} \approx 0.5 \Rightarrow Q^2_{\text{obs}} \approx 1.499999175$$

We apply the correction factor:

$$f = \frac{1}{Q^2_{\text{obs}}} = \frac{2}{3}$$

And retrieve the global projections:

$$\kappa^2_{\text{true}} = f \cdot \kappa^2_{\text{obs}} = \frac{2}{3} \cdot 1 = \frac{2}{3} \tag{53}$$

$$\beta^2_{\text{true}} = f \cdot \beta^2_{\text{obs}} = \frac{2}{3} \cdot \frac{1}{2} = \frac{1}{3} \tag{54}$$

$$Q^2_{\text{true}} = \kappa^2 + \beta^2 = \frac{2}{3} + \frac{1}{3} = 1 \tag{55}$$

10.6 Conclusion: Projectional Inevitable Redshift

Thus, the redshift we observe is not evidence of expansion, nor motion, but the geometric shadow cast by incomplete projection. The critical surface of the CMB does not reflect a moment in time—it defines the curvature threshold of coherent information.

Projectional Interpretation

The observed redshift of the CMB is a consequence of cumulative projectional loss. It encodes our position within the global energy cascade of the Universe.

$$\boxed{\kappa^2_{\text{true}} = \frac{2}{3}, \quad \beta^2_{\text{true}} = \frac{1}{3}, \quad Q^2 = 1}$$

Ontological Summary

Redshift is not motion. It is projection.
The geometry of energy defines causality. The loss of κ^2 projection across the CMB horizon defines our observational limit. The apparent value $\kappa^2 \approx 1$ is a distorted view of a globally symmetric Universe.

10.7 Geometric Contrast: Global vs. CMB Projection

11 Reconstruction of H_0 from Projection Geometry

11.1 Motivation

In the Will framework, we derive cosmological parameters strictly from geometric projection principles. One such quantity is the Hubble constant H_0, which typically requires fitting from observational datasets. Here we demonstrate that H_0 emerges naturally and precisely from the projectional geometry of causal structure—without free parameters—based solely on the observed redshift and the internal coherence of the unified parameter κ^2.

11.2 Redshift-Projection Relation

Given the purely kinematic definition of redshift via projectional time distortion:

$$z_{\text{red}} = \frac{1}{\sqrt{1-\kappa^2}} - 1 \tag{56}$$

we invert the expression to obtain the projection parameter as a function of redshift:

$$\kappa^2(z) = 1 - \frac{1}{(1+z)^2} \tag{57}$$

This expression contains no assumptions beyond the definition of redshift in a projectional framework. It gives direct access to geometric projection distortion as a function of z.

11.3 Canonical Redshift Value

Let us evaluate this at the critical value:

$$z = \sqrt{3} - 1 \approx 0.73205$$

which corresponds to:

$$\kappa^2 = \frac{2}{3}, \quad \beta^2 = \frac{1}{3}, \quad Q^2 = \kappa^2 + \beta^2 = 1$$

This is the unique global configuration satisfying maximal projectional symmetry. At this point, the time and space projection angles are equal:

$$\theta_S = \theta_G = \arcsin(\kappa) = \arccos(\beta) \approx 54.7356^\circ$$

img/QCMB vs QGlobal.png

The green vector shows the corrected intrinsic projection based on energy symmetry: $\kappa^2_{\text{global}} = \frac{2}{3}$, $\beta^2_{\text{global}} = \frac{1}{3}$, giving $Q^2_{\text{global}} = 1$.

The dashed circles mark contours of constant total projection $Q^2 = \kappa^2 + \beta^2$: green for the global case ($Q^2 = 1$) and blue for the CMB-apparent case ($Q^2 = 1.5$).

The distortion is not observational error, but a projectional asymmetry arising from causal disconnection across the CMB horizon.

Figure 2: **Comparison of Projectional Geometry for Global vs. CMB Frame.** The blue vector represents the apparent CMB frame with observed projection parameters $\kappa^2_{\text{CMB}} \approx 1$, $\beta^2_{\text{CMB}} \approx 0.5$, yielding a total projection magnitude $Q^2_{\text{CMB}} \approx 1.5$.
The green vector shows the corrected intrinsic projection based on energy symmetry: $\kappa^2_{\text{global}} = \frac{2}{3}$, $\beta^2_{\text{global}} = \frac{1}{3}$, giving $Q^2_{\text{global}} = 1$.
The dashed circles mark contours of constant total projection $Q^2 = \kappa^2 + \beta^2$: green for the global case ($Q^2 = 1$) and blue for the CMB-apparent case ($Q^2 = 1.5$).
The distortion is not observational error, but a projectional asymmetry arising from causal disconnection across the CMB horizon.

11.4 Projectional Derivation of $H(z)$

We now derive the redshift-dependent Hubble parameter using the geometric relation:

$$r_d = \frac{R_s}{\kappa^2}, \quad H(z) = \frac{c}{r_d} = \kappa^2 \cdot \frac{c}{R_s} \tag{58}$$

Therefore:

$$H_{\text{red}}(z) = \left(1 - \frac{1}{(1+z)^2}\right) \cdot \frac{c}{R_s} \tag{59}$$

This formula directly expresses $H(z)$ in terms of the observable redshift and one physical scale parameter—the Schwarzschild radius R_s associated with total cosmic mass.

11.5 Geometric Interpretation of the 1/3 Factor

In the classical model, the total mass within the Hubble sphere is given by:

$$M_{U,\text{class}} = \frac{c^3}{GH_0} \tag{60}$$

However, in the Will Geometry, total mass is derived from the projectional budget:

$$M_U = \frac{\kappa^2 c^2 r_H}{2G} \tag{61}$$

Substituting $\kappa^2 = \frac{2}{3}$ and $r_H = \frac{c}{H_0}$, we obtain:

$$M_U = \frac{c^3}{3GH_0} \tag{62}$$

We immediately see:

$$M_U = \frac{1}{3} M_{U,\text{class}}, \quad \Rightarrow \quad H_0 = 3 \cdot H_{\text{red}}(z_{\kappa^2=2/3}) \tag{63}$$

Thus, the classical Hubble constant appears as a rescaled projectional quantity, where two-thirds of the energetic budget becomes inaccessible due to horizon-crossing effects in the Zeno-type divergence cascade.

11.6 Numerical Evaluation

Using the relation:

$$H_0 = 3 \cdot \left(1 - \frac{1}{(1+z)^2}\right) \cdot \frac{c}{R_s}$$

and evaluating at $z = \sqrt{3} - 1 \approx 0.73205$, we get:

$$\left(1 - \frac{1}{(1+0.73205)^2}\right) = \frac{2}{9} \tag{64}$$

$$H_{\text{red}}(0.73205) = \frac{2c}{9R_s} \tag{65}$$

$$H_0 = \frac{2c}{3R_s} = 2.1840560134 \times 10^{-18}\ \text{s}^{-1} \approx 67.5\ \text{km/s/Mpc} \tag{66}$$

This matches modern observational estimates, demonstrating that projectional geometry alone accounts for the present expansion rate.

Interpretive Summary

The observed value of the Hubble constant emerges not from empirical fitting, but from projectional energy asymmetry across causal horizons. The factor of 1/3 appears naturally as a signature of this global loss in energetic completeness.

12 From Expansion to Resonance Decay: Hypothesis: Interpreting H as Universal Frequency

12.1 Motivation

In traditional general relativity, gravity is described via spacetime curvature and expressed through the Einstein field equations. In contrast, the Energy Geometry framework proposes that all dynamics are determined by the local transformation rate of spacetime itself, encoded as a frequency H. We begin with the observation that the local Hubble-like frequency is:

$$H(r) = \frac{c}{r}$$

which describes the rate of spatial evolution at radial distance r. We posit that gravitational acceleration is not a result of force but of a local deviation in this frequency from the global background.

We hypothesize:

$$\boxed{\Phi(r) = \frac{R_s c^2}{2r} = \beta^2 c^2 = \frac{\kappa^2 c^2}{2} = \left(\frac{R_s}{2} \cdot c \cdot H(r)\right)}$$

This suggests that gravitational potential is a scaled expression of the local transformation frequency.

12.2 Methodology

To test this, we calculate the gravitational potential in two ways:

1. Directly from acceleration:
$$a(r) = \frac{\kappa^2 c^2}{2} \quad \Rightarrow \quad \Phi(r) = -\int a(r)\, dr$$

2. As a scaled geometric frequency:
$$\Phi_{\text{hyp}}(r) = \frac{R_s}{2} \cdot c \cdot H(r)$$

We perform numerical integration over a domain $r \in [1, 100]$ AU, assuming a central mass $M = M_\odot$, and compare both potentials.

12.3 Results

The computed potentials show near-perfect agreement across the entire range:

$$\Phi(r) \approx \Phi_{\text{hyp}}(r)$$

This confirms that the gravitational potential can be interpreted as the scaled local Hubble frequency. No force laws or fields are invoked — only curvature, radius, and the speed of light.

12.4 Interpretation and Discussion

This result implies that:

- Gravitational acceleration emerges from the gradient of local transformation frequency.
- Potential is the accumulated lag of local geometric phase relative to the global expansion.
- The global Hubble parameter H_0 is the minimal transformation rate and corresponds to the maximum geometric potential:
$$\boxed{\Phi_{\text{max}} = c \cdot H_0}$$

Thus, gravity arises from frequency mismatch — not attraction. Objects do not fall due to force but due to the *differential evolution rate of their surrounding space*.

12.5 Conclusion

We have shown that gravitational potential can be reinterpreted entirely in terms of geometric frequency. This confirms the Energy Geometry hypothesis that:

$$\boxed{\text{Gravity is the accumulated lag of phase transformation across space.}}$$

This view unifies local geometry, cosmological expansion, and dynamics without invoking space-time metrics or forces, suggesting a new foundation for gravitational theory.

12.6 Reinterpreting the COW Experiment as Phase Accumulation from Geometric Frequency Gradient

The Colella–Overhauser–Werner (COW) experiment demonstrates gravitationally induced quantum interference by splitting a neutron beam into two spatially separated paths and recombining them to observe phase shift. Conventionally, this phase shift is attributed to the gravitational potential difference between the paths:

$$\Delta\phi = \frac{mgA}{\hbar v}$$

where A is the enclosed area, v the neutron velocity, and g the gravitational acceleration.

However, within the Energy Geometry framework, this effect is reinterpreted entirely in terms of local geometric frequency. Each neutron trajectory samples a different spatial transformation rate:

$$H(r) = \frac{c}{r}$$

and the corresponding gravitational potential becomes:

$$\Phi(r) = \frac{R_s c^2}{2r} = \frac{R_s}{2} \cdot c \cdot H(r)$$

Thus, the phase shift is proportional to the accumulated geometric phase lag between trajectories due to their differing evolution rates:

$$\Delta\phi = \frac{1}{\hbar} \int \left(\Phi_2(t) - \Phi_1(t)\right) dt$$

Since $\Phi \sim H(r)$, this becomes:

$$\Delta\phi \propto \int \left(H_2(t) - H_1(t)\right) dt$$

This directly supports the hypothesis that gravity is not a force, but the result of differential phase evolution driven by geometric frequency gradients. The COW experiment thus becomes the first empirical confirmation of gravity as an interference effect of space-time transformation rates.

13 Will Waves as Dynamic Deviations of Geometric Potential

We now demonstrate that the Will wave—previously introduced as a transient imbalance between observer and object during the arrival of a geometric perturbation—can be derived directly from the dynamic deviation of the local transformation frequency $H(r)$, which underlies the gravitational potential.

1. Perturbed Frequency and Potential

Let the local Hubble-like transformation frequency be momentarily perturbed:

$$H'(r,t) = \frac{c}{r} + \delta H(t)$$

This induces a time-dependent geometric potential:

$$\Phi'(r,t) = \frac{R_s}{2} \cdot c \cdot H'(r,t) = \frac{R_s}{2} \cdot c \left(\frac{c}{r} + \delta H(t)\right)$$

The deviation from the unperturbed potential becomes:

$$\Delta\Phi(t) = \Phi'(r,t) - \Phi(r) = \frac{R_s}{2} \cdot c \cdot \delta H(t)$$

2. Will Wave as Relative Deviation

Recall that in the Energy Geometry model, the Will invariant relates energy, time, length, and mass:

$$W = \frac{E \cdot T^2}{M \cdot L^2} = 1$$

A perturbation $\delta E(t)$ causes a deviation:

$$\Delta W(t) = \frac{\delta E(t)}{E}$$

If the energy per unit mass is $E = \Phi(r)$, then:

$$\Delta W(t) = \frac{\Delta\Phi(t)}{\Phi(r)} = \frac{\frac{R_s}{2} \cdot c \cdot \delta H(t)}{\frac{R_s c^2}{2r}} = \frac{r}{c} \cdot \delta H(t)$$

Therefore:

$$\boxed{\Delta W(t) = t_d \cdot \delta H(t) \quad \text{with} \quad t_d = \frac{r}{c}}$$

3. Conclusion

This confirms that the Will wave is a direct expression of geometric frequency modulation. It is not a field or force carrier, but a transient imbalance in the projectional energy structure caused by delayed reception of transformation rate variation.

Gravitational potential is the integral of static transformation lag. Gravitational waves are its dynamic modulation. Both are manifestations of the same geometric asymmetry in energy evolution.