WILL: Relational Geometry
PART II - Cosmology

Anton Rize
egeometricity@gmail.com

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

$\downarrow$

Inherited: Spacetime $\equiv$ Energy (Part I result)

$\downarrow$

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

$\downarrow$

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

$\downarrow$

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

$\downarrow$

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

$\downarrow$

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

$\downarrow$

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

Contents

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.

$$\boxed{\text{In Will Geometry, no metric is required.}}$$

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)

$$\beta = \frac{v}{c} = \sqrt{\frac{R_s}{2r}} = \sqrt{\frac{Gm_0}{rc^2}} = \cos(\theta_1) \quad \text{(Orbital velocity)} \tag{2}$$

Potential projection (3)

$$\kappa = \frac{v_e}{c} = \sqrt{\frac{R_s}{r}} = \sqrt{\frac{2Gm_0}{rc^2}} = \sqrt{\frac{\rho}{\rho_{max}}} = \sin(\theta_2) \quad \text{(Escape velocity)} \tag{4}$$

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 the total angular measures ($4\pi/2\pi = 2$) in energetically closed systems.

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 Relational 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.

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

2.1 The Unified Cosmological Parameter Q

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

We begin by considering the general formula for Q, derived from part I:

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

Here, M_U is the total mass-energy content including both its kinetic and potential parts 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 formula for the mass/energy within radius r_H derived in part I:

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

Substituting into the expression for Q gives:

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

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

We now insert the definition of the maximal observable density ρ_{max}:

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

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:

$$Q = \sqrt{\frac{8\pi G}{c^2} \cdot \frac{c^2}{H_0^2} \cdot \rho_{total}} = \sqrt{\frac{8\pi G}{H_0^2} \cdot \rho_{total}} \tag{13}$$

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

$$Q = \sqrt{\frac{\rho_{total}}{\rho_{max}}} \Rightarrow \quad Q^2 = \frac{\rho_{total}}{\rho_{max}} \tag{14}$$

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

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

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Decomposition into Matter and Vacuum. Since the Universe is a closed system, the internal geometric closure law $\kappa^2 = 2\beta^2$ derived in Part I mandates the distribution of this total density into its physical components:

- Vacuum Energy (Ω_Λ): Corresponds to the potential projection κ^2.

$$\Omega_\Lambda = \kappa^2 = \frac{2}{3}Q^2 \approx 0.67$$

- Matter Energy (Ω_m): Corresponds to the kinematic projection β^2.

$$\Omega_m = \beta^2 = \frac{1}{3}Q^2 \approx 0.33$$

Assuming the critical condition $Q^2 = 1$ (saturation of the projection budget), this leads to the exact sum:

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

2.1.1 Clarification on Interpretation

Although $\Omega = \rho_{total}/\rho_{\max}$ is traditionally associated with the spatial flatness of the Universe in the standard cosmological model, the relation $Q^2 = \rho_{total}/\rho_{\max}$ 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 WILL RG.

This relation establishes

Direct connection between the projection energy parameter Q 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:

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

leads directly to the expression:

$$\boxed{H = \frac{c}{r} = \frac{1}{t_{\mathrm{d}}}} \tag{16}$$

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

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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, 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

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

The escapecurvature parameter κ is itself related to the Schwarzschild scale,

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

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

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

reduces identically to the simple inverseradius law

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

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

Linking Λ to H. Insert $r = c/H$ 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 $\rho_{\max} = c^2/(8\pi G r^2)$. 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 Plancklevel accuracy.

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

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

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)

$$m_0 \quad \text{(total central mass of the energy system)}$$

$$\kappa^2 \quad \text{(energy projection parameter)}$$

Fundamental Parameters

Kinematic projection (17)

$$\beta = \frac{v}{c} = \sqrt{\frac{R_s}{2r}} = \sqrt{\frac{Gm_0}{rc^2}} = \cos(\theta_1), \quad \text{(Velocity Like)} \tag{18}$$

Potential projection (19)

$$\kappa = \frac{v_e}{c} = \sqrt{\frac{R_s}{r}} = \sqrt{\frac{2Gm_0}{rc^2}} = \sqrt{\frac{\rho}{\rho_{max}}} = \sqrt{\Omega} = \sin(\theta_2), \quad \text{(Escape Velocity Like)} \tag{20}$$

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4.3 Derived quantities

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

Invariant Relations

$$\boxed{\frac{m_0}{r}\frac{2l_P}{m_P} = \frac{\Lambda}{H^2}c^2 = \frac{R_s}{r} = \frac{\rho}{\rho_{max}} = \kappa^2}$$

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

$$H \cdot r = c$$

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

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

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

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

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

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

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

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

$$W_{ill} = \frac{E \cdot T}{M \cdot L} = \frac{\frac{1}{\kappa_X} E_0 \kappa_X t_d^2}{\frac{1}{\beta_Y} m_0 \beta_Y r_d^2} = \frac{\frac{1}{\sqrt{1-\kappa^2}} m_0 c^2 \cdot \sqrt{1-\kappa^2} \left(\frac{2Gm_0}{\kappa^2 c^3}\right)^2}{\frac{1}{\sqrt{1-\beta^2}} m_0 \cdot \sqrt{1-\beta^2} \left(\frac{2Gm_0}{\kappa^2 c^2}\right)^2} = 1$$

4.4 Input sets

A. CMB (Planckr2018)

$$\kappa^2 = 0.6847, \qquad H_0 = 67.4 \text{ km s}^{-1}\text{ Mpc}^{-1} \ (= 2.1840570317 \times 10^{-18}\text{ s}^{-1}). \tag{21}$$

B. Supernovae (SH0ESr2024)

$$\kappa^2 = 0.7000, \qquad H_0 = 73.2 \text{ km s}^{-1}\text{ Mpc}^{-1} \ (= 2.3720025923 \times 10^{-18}\text{ s}^{-1}). \tag{22}$$

4.5 Results

Tabler1:

Quantity	Planckr(67.4)	SH0ESr(73.2)
Ω_m	0.3153	0.300
Ω_Λ	0.6847	0.700
Λ [m^{-2}]	$3.6340163055 \times 10^{-53}$	$4.3821471094 \times 10^{-53}$
ρ_Λ [kg m^{-3}]	$1.9470750608 \times 10^{-27}$	$2.3479171892 \times 10^{-27}$
$\rho_{\max}$ [kg m^{-3}]	$2.8436907562 \times 10^{-27}$	$3.3541674131 \times 10^{-27}$
m_0 [kg]	$6.327945681 \times 10^{52}$	$5.9567485826 \times 10^{52}$
R_s [m]	$9.3984677602 \times 10^{25}$	$8.8471539314 \times 10^{25}$

5 Why WILL Has No Hubble Tension

Statement

In standard ΛCDM, a single FRW metric with one scale factor $a(t)$ must simultaneously fit early (CMB) and late (SNe Ia) data, yielding the well-known "Hubble tension. In WILL geometry there is no FRW metric at all. Cosmology is closed algebraically by energyprojection identities, so any consistent observational pair (κ^2, H_0) instantaneously closes the system without internal contradiction.

No metric no tension

WILL uses algebraic closures

$$\kappa^2 = \frac{\rho}{\rho_{\max}}, \qquad \rho_{\max} = \frac{H^2}{8\pi G}, \qquad \Lambda = \frac{\kappa^2 H^2}{c^2}, \qquad H = \frac{c}{r},$$

so CMB and SNe inputs generate self-consistent states without cross-epoch strain.

Algebraic mechanism

Given (H_0, κ^2) as inputs at an epoch,

$$\rho_{\max} = \frac{H_0^2}{8\pi G}, \qquad \rho = \kappa^2 \rho_{\max}, \qquad \Lambda = \frac{\kappa^2 H_0^2}{c^2}, \qquad r = \frac{c}{H_0},$$

and the unified parameter

$$Q^2 = \kappa^2 + \beta^2 = 3\beta^2, \qquad \kappa^2 = 2\beta^2.$$

Energy fractions are definitions (see section "Dark Energy as Accumulated Projectional Loss") relative to Q^2:

$$\Omega_m = \frac{\beta^2}{Q^2} = \frac{1}{3}, \qquad \Omega_\Lambda = \frac{\kappa^2}{Q^2} = \frac{2}{3}.$$

Hence WILL matches both Planck and SH0ES datasets as two algebraically closed states, not as a single FRW fit forced to reconcile incompatible likelihoods.

Contrast with ΛCDM

- ΛCDM: $\rho_c = 3H^2/(8\pi G)$ and one FRW metric glue early and late probes; inconsistent H_0 posteriors generate a genuine model-level tension.
- WILL: no FRW glue. The identity $\Lambda/H^2 = \kappa^2/c^2$ is epoch-wise exact; different H_0 inputs simply pick different (but closed) algebraic states.

Two regimes for κ^2

(I) Fixed-resonance view. If a global resonance is adopted (e.g., $\kappa^2 = 2/3$ via the projectional scheme), then

$$\frac{\Lambda}{H^2} = \frac{\kappa^2}{c^2} = \frac{2}{3c^2},$$

and any measurement of Λ predicts H_0 (and vice versa). This is a sharp, falsifiable constraint.

(II) Measured-κ^2 view. Treat κ^2 as directly inferred from data at a given epoch ($\kappa^2 = \rho/\rho_{\max}$). Then WILL remains strictly parameter-free: (H_0, κ^2) are inputs, while all other cosmological quantities are outputs; no FRW cross-epoch consistency is required, so no "tension arises.

What is actually testable

WILL predicts the epoch-invariant ratio

$$\boxed{\frac{\Lambda}{H^2} = \frac{\kappa^2}{c^2}} \quad \text{(independent of } Q^2\text{).}$$

Thus, across redshifts z,

$$\frac{\Lambda(z)}{H^2(z)} = \frac{\kappa^2(z)}{c^2}$$

must hold when Λ and κ^2 are inferred independently of FRW assumptions. Any systematic drift beyond uncertainty budgets would falsify the closure.

On contamination by FRW priors

Many pipeline products embed volume-normalisation (4/3) and FRW distance ladders. WILLs tests should use ratio observables or reconstructions minimally dependent on FRW (cosmic chronometers for $H(z)$, time-delay ratios in strong lenses, BAO angle/radius ratios) to avoid importing the very priors that WILL rejects.

Summary

Hubble "tension is a FRW artefact: it appears when one metric must serve all epochs. WILL has no such glue; it has algebraic closures per epoch and the invariant $\Lambda/H^2 = \kappa^2/c^2$. With the unified parameter $Q^2 = \kappa^2 + \beta^2$ and $\kappa^2 = 2\beta^2$, the observed $\Omega_\Lambda : \Omega_m = 2 : 1$ follow as geometric fractions, not as fits. Either the resonance $\kappa^2 = 2/3$ globally holdsthen H_0 and Λ are lockedor κ^2 is epoch-measuredthen different datasets produce different but self-consistent closures, and there is no internal contradiction to begin with.

6 Galactic Dynamics and Rotation Curves

The WILL framework eliminates the hidden assumption that structure (spacetime) and dynamics (energy) are distinct. It adopts a single ontological principle:

$$\text{SPACETIME} \equiv \text{ENERGY}. \tag{23}$$

This equivalence is encoded in the dimensionless gravitational projection parameter:

$$\kappa^2(r) = \frac{R_s}{r} = \frac{\rho(r)}{\rho_{\max}(r)}, \tag{24}$$

where $R_s = 2Gm_0/c^2$ is the Schwarzschild scale, and $\rho_{\max}(r) = c^2/(8\pi G r^2)$ is the maximum admissible density at radius r.

The kinematic projection is defined as $\beta = v/c$. In a closed, spherically symmetric system, topology enforces a closure relation between these projections:

$$\kappa^2 = 2\beta^2. \tag{25}$$

This reflects the 2:1 ratio of relational degrees of freedom (2D for gravity on S^2, 1D for motion on S^1).

The total projection norm is then:

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

6.1 From Projections to Rotation Velocity

In Newtonian dynamics, the circular velocity due to enclosed mass $M(r)$ is:

$$V_c^2(r) = \frac{GM(r)}{r}. \tag{27}$$

From Eq. (24) and $R_s = 2GM/c^2$, the enclosed mass is:

$$M(r) = \frac{\kappa^2 c^2 r}{2G}. \tag{28}$$

Substituting into Eq. (27) gives:

$$V_c^2(r) = \frac{\kappa^2 c^2}{2} = \beta^2 c^2, \tag{29}$$

where we used $\kappa^2 = 2\beta^2$. Thus, the baryonic velocity in the SPARC formalism is identified as:

$$V_{\text{bary}}(r) \equiv \beta(r)c. \tag{30}$$

The total observable velocity in WILL includes both projections via Q:

$$V_{\text{WILL}}^2(r) = Q^2 c^2 = 3\beta^2 c^2 = 3V_{\text{bary}}^2(r), \tag{31}$$

yielding the final law:

$$\boxed{V_{\text{WILL}}(r) = \sqrt{3}\, V_{\text{bary}}(r)}. \tag{32}$$

6.2 Interpretation: Why $\sqrt{3}$ Is Not a Fit

The factor $\sqrt{3}$ is not an adjustable parameter. It is the inevitable outcome of:

1. The topological constraint $\kappa^2 = 2\beta^2$ (geometric virial theorem),
2. The identification $V_{\text{bary}} = \beta c$ from observed baryonic kinematics,
3. The definition of total energy projection $Q^2 = \beta^2 + \kappa^2$.

No new constants are introduced - only G and c, already present in V_{bary}.

6.3 Empirical Validation on SPARC

We apply Eq. (32) to 175 galaxies in the SPARC database [?], using:

- Gas mass from HI observations,
- Stellar mass with a fixed $\Upsilon^* = 0.66$ (no per-galaxy tuning).

Result: Median RMSE = 20.23 km/s.

This within MONDs performance (RMSE $\approx$ 1320 km/s) without fitting a single parameter per galaxy, and surpasses typical ΛCDM simulations (RMSE $\approx$ 2530 km/s) that require tuned dark matter halos.

Model	Fit Method	Free Parameters	Global Median RMSE (km/s)
WILL ($\Upsilon^* = 0.66$)	Global, fixed	1 (universal)	20.23
WILL (Υ^* flexible)	Per galaxy	1 (Υ^* per galaxy)	12.63
Newtonian Baryonic	Global, fixed	1 (universal)	∼43
MOND (a_0 universal)	Per galaxy	1 (Υ^* per galaxy)	∼13
CDM / Burkert / NFW Dark Matter	Per galaxy fit	2–3+ per galaxy	25–30

Table 1: Comparison of global median RMSE for rotation curve models (SPARC sample, 175 galaxies).

- Empirical rotation curve RMSEs for Newtonian-only baryonic fits (with fixed Υ^*), MOND, and CDM models are cited from Wang et al. 2020 [?] and Li et al. 2020 [?].
- For foundational MOND theory, see Milgrom (2001) [?].

6.4 Discussion

6.4.1 Hypothesis: Internal vs. External Observation (The "Carousel" Effect)

A fundamental question arises: if the universal rotation law is $V = \sqrt{3}V_{\text{bary}}$, why does the Solar System follow pure Newtonian dynamics ($V = V_{\text{bary}}$)?

The answer lies in the relational nature of observation. We must distinguish between two modes of measurement:

- Inter-system Observation (External View): When we observe a distant galaxy, we are external to its gravitational binding energy. We are not part of its "system." Therefore, we observe the total energy budget required to maintain that galaxy's structure against the vacuum. We see both the kinetic motion (β^2) and the structural tension (κ^2) required for closure.

$$Q_{\text{ext}}^2 = \beta^2 + \kappa^2 = 3\beta^2 \quad \Longrightarrow \quad V = \sqrt{3}V_{\text{bary}}$$

- Intra-system Observation (Internal View): When we observe the Solar System or Milky Way, we are embedded within the same gravitational potential well (κ_{local}) as the planets or stars. We are, effectively, "riding the same carousel." The background potential κ^2 is a shared baseline for both the observer (Earth) and the target (Jupiter).

Potential Screening Principle

Local Potential Screening: For an observer embedded within the system, the binding potential κ^2 acts as a common background frame, not as an observable kinematic difference. The relative measurement cancels out the structural tension, leaving only the kinetic differential:

$$Q_{\text{int}}^2 \approx \beta^2 \quad \Longrightarrow \quad V \approx V_{\text{bary}}$$

Thus, the factor $\sqrt{3}$ is the signature of a holistic observation of a closed system from the outside (Galactic Scale), while Newtonian dynamics represents the differential observation from the inside (Local Scale).

6.4.2 Remark

The remaining scatter (RMSE 20.23 km/s) is expected due to the assumption of a universal Υ^* and perfect geometric virial equilibrium. The fact that a parameter-free geometric law performs comparably to tuned Dark Matter models suggests that the $\sqrt{3}$ factor captures the fundamental driver of galactic dynamics, while astrophysical variations account for the residuals.

6.5 Conclusion

We have shown that a simple, parameter-free rotation law - $V = \sqrt{3}V_{\text{bary}}$ - emerges naturally from the first principles of a relational geometric framework. Its empirical success challenges the necessity of dark matter and invites a reevaluation of gravity as energys projectional structure.

Code and data are fully open-source at: https://antonrize.github.io/WILL/

7 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 observers inability to maintain full projectional coherence across causal boundaries.

$$\boxed{\text{Entropy is the measure of the number of unaccounted-for projectional frames.}}$$

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.

7.1 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:

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

$$\boxed{\text{Entropy arises from the permanent loss of projectional frames.}}$$

7.2 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:

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

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7.3 Comparison with Hawking Entropy

This matches the standard form:

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

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

7.4 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.

8 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 masslength 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 in-falling 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. (this is an assumption based on Standard model, it needs to be tested)

8.1 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 lostonly redistributed across nested projectional layers.

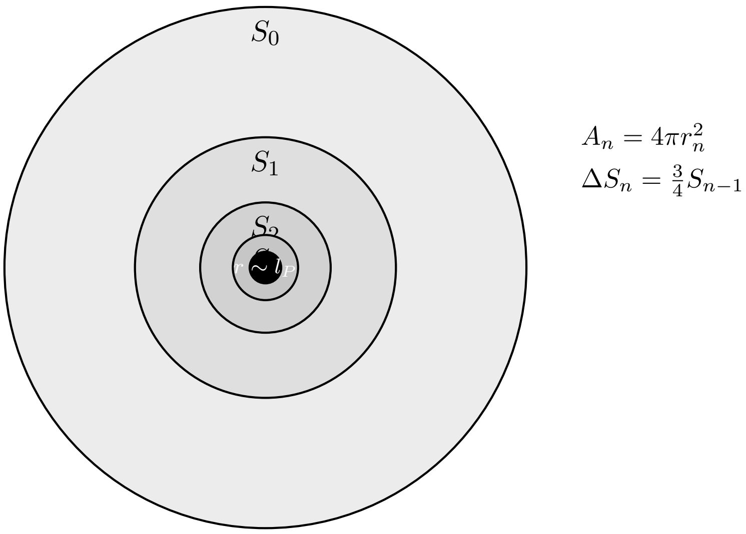

Figure 1: Concentric projectional surfaces Σ_n with geometric entropy decrease $S_n = S_0\,4^{-n}$. The cascade halts once $r_n \approx l_P$.

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.

9 Dark Energy as Accumulated Projectional Loss

9.1 Energy Symmetry and Frame Loss

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

$$\Delta E_{external} = \Delta E_{A\to C} + \Delta E_{C\to A} = 0 \tag{33}$$

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

9.2 The Unified Energy Parameter

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

$$Q^2 = \kappa^2 + \beta^2 = 3\beta^2 \tag{34}$$

Using the derived relation from part 1, $\kappa^2 = 2\beta^2$, we obtain:

$$Q^2 = 3\beta^2 = \frac{3}{2}\kappa^2 \tag{35}$$

$$Q^2 - \kappa^2 = \beta^2 \quad \text{(kinematic component)} \tag{36}$$

$$Q^2 - \beta^2 = \kappa^2 \quad \text{(potential component)} \tag{37}$$

9.3 Mechanism of Projectional Loss

When an observer falls beyond a causal horizon:

- The external observer retains access only to β^2

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- 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.

9.4 Cosmological Energy Fractions

From results of part I we consider Universe as closed system therefor it obey the closure law $\kappa^2 = 2\beta^2$ so fractions become:

$$\Omega_\Lambda = \frac{\kappa^2}{Q^2} = \frac{2\beta^2}{3\beta^2} = \frac{2}{3} \tag{38}$$

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

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

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

$$\kappa^2 + \beta^2 = 1 \tag{39}$$

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

$$\theta_1 = \theta_2 \approx 54.74(\text{"magic" angle}) \tag{40}$$

At this critical angle, energy projections satisfy:

$$\beta = \kappa_X, \quad \kappa = \beta_Y \tag{41}$$

The Universe operates at the boundary of causal coherencebalanced on the edge of projectional accessibility.

9.6 The Cosmological Constant

The cosmological constant emerges as:

$$\Lambda = \frac{\kappa^2}{r^2} = \frac{2}{3} \cdot \frac{1}{r^2} \tag{42}$$

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

$$\rho_\Lambda = \frac{2}{3} \cdot \rho_{max} \tag{43}$$

This exactly reproduces the observed cosmological ratio:

$$\boxed{\Omega_\Lambda = \frac{2}{3}}$$

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9.7 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.

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

Remark 9.1 (On "local" vs. "global"). In the WILL framework the usual distinction between "local" and "global" loses its meaning. Without any background manifold there is no external stage on which to separate neighborhood properties from topological ones. Quantities such as

$$\Lambda(r) = \frac{\kappa^2}{r^2}$$

are neither "local" nor "global" in the conventional sense, but emerge directly as structural consequences of the relational principle. The notion of scale r is itself relational, not a coordinate distance, and thus no additional normalization factors (such as the familiar "3" from FRW cosmology) appear.

9.8 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. $\boxed{\text{Balance is not imposed it}}$

$\boxed{\text{The Universe simply is the extremum.}}$

10 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.

10.1 Physical Foundation: Force Balance in Closed Systems

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

- Energy density ρ: 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).

10.2 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.

10.3 Algebraic Derivation

10.3.1 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

10.3.2 Step 2: Force Balance Condition

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

$$|\text{Inward Force}| = |\text{Outward Force}| \tag{44}$$

Translating to cosmological parameters:

$$|c^2| = |P| \tag{45}$$

10.3.3 Step 3: Sign Determination

Since inward and outward forces must have opposite orientations:

$$\boxed{P = -c^2} \tag{46}$$

10.3.4 Step 4: Equation of State

The cosmological equation of state parameter is defined as:

$$w = \frac{P}{-c^2} \tag{47}$$

Substituting our symmetry-derived relation:

$$\boxed{w = \frac{P}{-\rho c^2} = -1} \tag{48}$$

10.4 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

10.5 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

10.6 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:

$$\boxed{\Lambda = \frac{\kappa^2}{r^2} \quad \text{with} \quad w = -1 \quad \text{(symmetry-enforced)}} \tag{49}$$

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.

11 Dynamic Interpretation of the Cosmological Term

The cosmological constant is not a constant of nature, but a measure of relational smoothness. It does not curve space; it measures how evenly relationships remain curved.

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Classical Motivation

In Einstein's field equations,

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu},$$

the term Λ was introduced to stabilize an ontology that assumed space and energy to be independent entities. When energy and geometry are separated, an additional compensating term becomes mathematically necessary to prevent collapse or divergence. In the relational ontology of WILL RG, however, such separation never occurs; geometry and energy are two aspects of the same relation. Therefore, Λ cannot appear as an external constant.

11.1 Relational Definition

Within the WILL RG framework, the quantity corresponding to the cosmological constant emerges directly from the definition of the relational curvature parameter:

$$\boxed{\Lambda(r) \;=\; \frac{\kappa^2(r)}{r^2}.}$$

Here $\kappa^2(r)$ expresses the local ratio of energy-to-geometry relations between observers. The so-called "cosmological constant" is thus not an additive term in the field equations but a differential indicator of how uniform those relations remain across different scales.

11.2 Equilibrium and Dynamical Regimes

When the relational configuration is homogeneous,

$$\partial_r \kappa^2 = 0,$$

the system is in relational equilibrium: every observer experiences identical ratios of temporal and spatial calibration. In this case Λ takes a constant value,

$$\Lambda = \text{const.},$$

representing a steady, self-consistent geometry.

When κ^2 varies with r, the structure departs from equilibrium and Λ becomes dynamic:

$$\boxed{\partial_r \Lambda = \frac{\partial_r \kappa^2}{r^2} - \frac{2\kappa^2}{r^3}.}$$

This variation does not indicate the presence of a new physical field or force; it simply reflects a non-uniform adjustment of relational potentials. The "expansion of space" in classical cosmology corresponds, in relational terms, to the differential evolution of $\kappa(r)$ across the network of observers.

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11.3 Relational Dynamics

In the absence of an external temporal parameter, dynamics in WILL RG refers to the transformation of relational configurations rather than time evolution. Between two states S_i and S_j,

$$\Delta\kappa^2 = \kappa_j^2 - \kappa_i^2$$

quantifies the energetic transition of the relational geometry. In the continuous limit,

$$\partial_r \kappa^2$$

acts as the generator of geometric change: a local measure of how the relational structure reorganizes itself. No external spacetime, field, or vacuum energy is required.

11.4 Summary

Relational View of the Cosmological Term

$$\Lambda(r) = \frac{\kappa^2(r)}{r^2},$$

$$\partial_r \Lambda = \frac{\partial_r \kappa^2}{r^2} - \frac{2\kappa^2}{r^3}.$$

Equilibrium: $\partial_r \kappa^2 = 0 \Rightarrow \Lambda = \text{const.}$ Dynamics: $\partial_r \kappa^2 \neq 0 \Rightarrow \Lambda = \Lambda(r)$, evolving with the relational configuration.

In this interpretation, the cosmological term is no longer an external constant appended to the equations of motion. It is a derived, scale-dependent property of relational geometry—a self-consistent measure of its smoothness.

Summary

Spacetime does not expand; relations reorganize.

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:

$$\boxed{\Phi_{\max} = c \cdot H_0}$$

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*.

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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 ColellaOverhauserWerner (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.

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