Cosmological Redshift, Conformal Lattice Eversion, and Distance Metrics in CPT

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Abstract

Cosmological redshift—the proportional shift of spectral lines toward the red in distant objects—is standardly interpreted as a metric stretching of photons in an expanding FLRW spacetime governed by General Relativity (ΛCDM). In the CPT framework, the physical spatial container is an invariant, static 3-sphere $S^3(R)$ of metric radius $R = \sqrt{6} c / H_0 \approx 3.285 \times 10^{26}\text{ m}$ with zero coordinate expansion ($\dot{R} = 0$). Cosmological redshift is formally defined as the **conformal scale factor $1+z = 1/a(t) = R_0/R$ of the everting vacuum torus-knot lattice** (`[M geodesic packaging]`, §0bn1132), producing a linear coasting expansion profile $H(z) = H_0(1+z)$.

We demonstrate three foundational results: 1. **Container Lock & LLR Defense:** The physical container radius is spectrally locked ($\dot{R} = 0$), guaranteeing $\dot{G} = 0$ and completely evading the Lunar Laser Ranging ($M12$) limit that kills expanding-coordinate Machian models at 930σ. 2. **Liouville Decoupling:** Phase-space conservation along null geodesics guarantees that the Tolman surface brightness relation $I(z) \propto (1+z)^{-4}$ and Etherington reciprocity $d_L = (1+z)^2 d_A$ hold identically for any conserved null frequency ratio, decoupling surface brightness dimming from metric coordinate expansion ($\dot{R} \neq 0$). 3. **Zero Dark Energy ($\Lambda = 0$):** The coasting luminosity distance $d_L(z) = \frac{c}{H_0}(1+z)\ln(1+z)$ naturally produces the observed $\sim 0.25\text{ mag}$ Type Ia supernova dimming relative to a decelerating matter baseline, completely eliminating the need for a dark energy fluid ($\Lambda = 0$).

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1. The Framework Redshift Definition: Conformal Lattice Eversion

Standard cosmology equates redshift directly with physical coordinate expansion of the metric tensor: $g_{\mu\nu} = \text{diag}(-c^2, a^2(t) \gamma_{ij})$. In CPT, early investigations evaluated and rejected classical non-expanding mechanisms: * **Tired Light ($z = d/R_{\text{eff}}$):** Evaluated and refused. Simple photon energy loss predicts a Hubble slope of only $H_0 \approx 28.16\text{ km/s/Mpc}$ and violates Fraunhofer line-width preservation. * **Bulk Mass Gravitational Potential:** Evaluated and refused. The static S^3 Green potential produces a central potential well predicting blueshift ($+r^2$), not Hubble redshift.

In §0bn1132 (`a_geom_ft_redshift_definition_conformal_eversion.md`), the formal framework definition was placed:

$$\boxed{1+z = \frac{1}{a(t)} = \frac{R_0}{R(t)}}$$

Redshift is the conformal scale factor of the everting vacuum torus-knot lattice (`[M geodesic packaging]`).

Under velocity-dependent Weber electrodynamic gravity, the gravitational potential contains a velocity-dependent term that suppresses deceleration at expansion velocities. This drives the vacuum lattice into a stable linear coasting regime:

$$a(t) = a_0 (1 + H_0 t) \implies H(z) = H_0 (1+z)$$

The previous interim note that no framework redshift definition was written is formally **withdrawn**. Cosmological redshift is the progressive dilation of atomic emission wavelengths relative to the everting vacuum background along null geodesics.

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2. Container Lock and the Lunar Laser Ranging ($M12$) Defense

A central triumph of the CPT formulation is reconciling cosmological redshift with the stringent experimental constraints of local gravitational physics (§0bn1131).

If the physical container $S^3(R)$ were expanding dynamically at $\dot{R}/R = H_0$, then under Machian closure ($M = N_{\text{pack}} m_p \propto R^2$), Newton's gravitational constant would scale inversely with radius:

$$G \propto \frac{1}{R} \implies \frac{\dot{G}}{G} = -\frac{\dot{R}}{R} = -H_0 \approx -7.05 \times 10^{-11}\text{ yr}^{-1}$$

Lunar Laser Ranging (LLR) and solar-system ephemerides measure $|\dot{G}/G| < (7.1 \pm 7.6) \times 10^{-14}\text{ yr}^{-1}$. A physical metric expansion of coordinates would fire the $M12$ gate, being ruled out at **930σ**.

In CPT, the container is spectrally locked:

$$\dot{R} = 0 \implies \dot{G} = 0$$

The spatial 3-sphere radius $R = \sqrt{6} c / H_0 \approx 3.2852 \times 10^{26}\text{ m} \approx 10.6\text{ Gpc}$ is an invariant structural constant of the global geometry. Expansion is **conformal**

eversion of the internal vacuum lattice, not metric coordinate stretching of the embedding space. This protects the framework entirely from the $M12$ LLR catastrophe.

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3. Liouville Decoupling: Surface Brightness on Null Geodesics

The Tolman surface brightness test measures the scaling of surface brightness $I(z)$ with redshift. Standard literature frequently claims that only an expanding metric spacetime can produce the steep $(1+z)^{-4}$ dimming, whereas static models must scale as $(1+z)^{-1}$.

In §0bn1131 (`a_geom_ft_referee_redshift_five_errors_audit.md`), we proved this claim to be mathematically false via Hamiltonian optics:

1. **Liouville's Theorem:** In geometric optics along null geodesics, the photon distribution function (phase-space density) is invariant: $$\frac{d f}{d\lambda} = 0, \quad \text{where } f = \frac{I_\nu}{\nu^3}$$
2. **Frequency Integration:** Integrating the specific intensity $I_\nu = \nu^3 f$ over all frequencies between emission (ν_e) and observation ($\nu_o = \nu_e / (1+z)$): $$I_o = \int I_{\nu_o} d\nu_o = \int \nu_o^3 f d\nu_o = \frac{1}{(1+z)^4} \int \nu_e^3 f d\nu_e = I_e (1+z)^{-4}$$
3. **Reciprocity Theorem:** The Etherington distance reciprocity relation follows identically from phase space conservation: $$d_L(z) = (1+z)^2 d_A(z)$$

Tolman $(1+z)^{-4}$ dimming holds identically for ANY conserved-photon frequency ratio on null geodesics. It does not require $\dot{R} \neq 0$. The observed surface brightness dimming in deep-field galaxies is an exact consequence of null-geodesic phase space conservation under conformal eversion frequency shift $1+z$, completely compatible with a static container $S^3(R)$.

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4. Supernova Dimming Without Dark Energy ($\Lambda = 0$)

In 1998, Type Ia supernovae (SNIa) observations revealed an apparent $\sim 0.25\text{ mag}$ dimming at $z \sim 0.5 - 1.0$ compared to the matter-dominated Einstein-de Sitter ($\Omega_m = 1$) prediction. General Relativity explained this dimming by introducing a repulsive cosmological constant $\Omega_\Lambda \approx 0.70$.

In the CPT framework, **the vacuum has strictly zero dark energy fluid: $\Lambda = 0$** (§0bn1078).

The Coasting Luminosity Distance

In a linearly coasting universe governed by conformal eversion ($H(z) = H_0(1+z)$), the comoving radial distance is:

$$r(z) = \int_0^z \frac{c}{H(z')} dz' = \frac{c}{H_0} \int_0^z \frac{dz'}{1+z'} = \frac{c}{H_0} \ln(1+z)$$

Applying the Liouville reciprocity relation, the luminosity distance is:

$$d_L^{\text{coasting}}(z) = (1+z) r(z) = \frac{c}{H_0} (1+z) \ln(1+z)$$

Comparison with Einstein-de Sitter

In a flat, matter-dominated decelerating Einstein-de Sitter universe:

$$d_L^{\text{EdS}}(z) = \frac{2c}{H_0} (1+z) \left[1 - \frac{1}{\sqrt{1+z}} \right]$$

The distance modulus difference is:

$$\Delta\mu(z) = \mu_{\text{coasting}} - \mu_{\text{EdS}} = 5 \log_{10} \left(\frac{d_L^{\text{coasting}}(z)}{d_L^{\text{EdS}}(z)} \right) = 5 \log_{10} \left(\frac{\ln(1+z)}{2[1 - (1+z)^{-1/2}]} \right)$$

Evaluating this difference across typical supernova redshifts:

Redshift z	**$d_L^{\text{coasting}} / (c/H_0)$**	**$d_L^{\text{EdS}} / (c/H_0)$**	**$\Delta\mu$ (Magnitude Dimming)**
0.2	0.2188	0.2073	**$+0.117\text{ mag}$**
0.5	0.6082	0.5505	**$+0.217\text{ mag}$**
0.8	1.0580	0.9168	**$+0.288\text{ mag}$**
1.0	1.3863	1.1716	**$+0.320\text{ mag}$**

The apparent supernova dimming is an exact consequence of linear coasting ($\ddot{a} = 0$). The supernovae are dimmer than the classical Newtonian baseline not because the universe is accelerating ($\ddot{a} > 0$), but because it is **not decelerating**!

When standard ΛCDM models force-fit this linear coasting profile into the decelerating Friedmann equation with $\Omega_m \approx 0.3$, they are forced to invent an artificial dark energy density $\Omega_\Lambda \approx 0.70$ and an evolving equation of state (w_0, w_a) to match the data.

5. Summary of Cosmological Sky Observables

Observable	Standard ΛCDM Interpretation	CPT Framework Resolution	Tag
Cosmological Redshift z	Expanding metric scale factor $\dot{a}(t)$	Conformal vacuum lattice eversion $1+z = 1/a(t)$	**[M]**
Hubble Parameter H_0	Free parameter ($67-73\text{ km/s/Mpc}$)	$H_0 = 68.973\text{ km/s/Mpc}$ from Hierarchy Bridge	**[P]**
Tolman Surface Brightness	Proof of expanding metric coordinates	Hamiltonian phase space conservation on null paths	**[E]**
Supernova Dimming ($\sim 0.25\text{ mag}$)	Dark energy fluid ($\Omega_\Lambda \approx 0.70$)	Coasting distance $d_L = \frac{c}{H_0}(1+z)\ln(1+z)$, $\Lambda = 0$	**[E]**
Lunar Laser Ranging	Requires fine-tuned $\dot{G} = 0$	Static container $\dot{R} = 0 \implies \dot{G} = 0$ exact	**[E]**
Spatial Flatness	Fine-tuned inflation ($\Omega_k \approx 0$)	Non-diverging $S^3(R)$ geometry ($r^2/R^2 \ll 1$)	**[E]**

6. Falsifiable Observational Predictions

1. **Zero Late-Time Deceleration Boundary ($q \to 0$):** At high redshifts ($z > 5$), the effective deceleration parameter asymptotically approaches flat coasting ($q \to 0$), without the runaway cosmic “rip” predicted by phantom dark energy models.
2. **Absolute Constancy of G:** Lunar Laser Ranging and pulsar timing arrays will continue to find $\dot{G}/G = 0$ with increasing precision, consistent with static container lock $\dot{R} = 0$.
3. **Line-Width Invariance:** High-resolution spectroscopy of quasar absorption lines (e.g., HI Lyman-α forest) will confirm strict preservation of Fraunhofer line profiles, matching conformal eversion and ruling out tired-light scattering models.