A Contraction-Driven Cosmological Model Without Expansion, Dark Energy, or Inflation

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Abstract

We propose a unified contraction-based cosmological framework in which the multiverse undergoes an exponential, isotropic decrease of scale governed by a universal geometric rate C. All physical quantities with dimensions of length, time, and energy density evolve proportionally with the contraction factor $R(t)$, making global contraction locally unobservable to internal observers whose instruments shrink synchronously. By synthesising ideas from Expanding Spacetime Theory, Scale Relativity, Infinite Universe Theory and Lorentz-invariant Newtonian metric cosmology, we obtain a non-singular and scale-covariant description of cosmic dynamics. The framework provides natural explanations for redshift, Type Ia supernova dimming, cosmic microwave background (CMB) temperature evolution, baryon acoustic oscillations (BAO), gravitational lensing, galaxy rotation curves, and the Hubble tension without invoking dark energy, inflation, or dark matter halos. Time emerges as a logarithmic measure of cumulative contraction, and radiation is reinterpreted as oscillatory perturbations within the contracting geometric medium. This contraction paradigm offers a coherent theoretical and observational alternative to the standard ΛCDM model.

1 Introduction

Standard cosmology describes the universe as expanding from an initially extremely dense and hot state, according to the Big Bang picture. The redshift of distant galaxies and the existence of the CMB are interpreted as evidence for this expansion. Within the ΛCDM paradigm, the universe is said to have begun approximately 13.8 Gyr ago from a singularity, followed by an inflationary phase and a subsequent epoch of matter- and dark-energy–dominated expansion.

Despite its empirical successes, this picture raises conceptual questions: into what does the universe expand, what produced the initial singularity, and why should the initial conditions be so finely tuned? Furthermore, it assumes that measurement scales are fixed while the universe evolves with respect to them.

In contrast, the present work develops a framework in which the universe — and the multiverse as a whole — is not expanding but *contracting* at a universal geometric rate C. All physical scales—length, time, mass, energy density—evolve proportionally with $R(t)$, so that an internal observer, whose instruments contract synchronously, perceives an apparently static or even expanding cosmos. The goal of this article is to formulate this contraction paradigm mathematically, connect it to an explicit metric structure, confront it with cosmological observations, and examine its philosophical implications.

1.1 Perception, measurement, and scale invariance

Human sensory perception evolved to interpret local physical interactions, not cosmological dynamics. Our intuitions about length, time and mass arise from relative comparisons that implicitly assume the stability of the instruments we use. If the universe and all of its contents contract proportionally, then the observer cannot perceive the contraction directly, because the reference scales themselves are shrinking at the same rate as the quantities being measured.

Formally, let $L_o(t)$ denote the length of an object and $L_r(t)$ the length of a ruler. If both scale with the same factor $R(t)$,

$$L_o(t) = L_{o0}R(t), \qquad L_r(t) = L_{r0}R(t), \tag{1}$$

then the measured ratio is

$$\frac{L_o(t)}{L_r(t)} = \frac{L_{o0}}{L_{r0}}, \tag{2}$$

which is time independent. The observer concludes that the object has a constant length, even though both object and ruler may be contracting exponentially.

The same reasoning applies to time intervals, masses, and energies, leading to an *illusion of constancy* in a dynamically contracting reality. From this point of view, many "facts" of cosmology — such as the apparent expansion of the universe — may be consequences of assuming fixed measurement scales rather than results of direct observation.

1.2 The cosmological need for a scale-based interpretation

The conceptual difficulties of the Big Bang plus inflation scenario are well known: the horizon problem, the flatness problem, the singularity problem and the cosmological constant problem all reflect an underlying tension between observed large-scale order and the mathematical structure of the theory. A common feature of these difficulties is the implicit assumption that the units of length, time and mass are *absolute*, while the universe evolves in those units.

In a scale-based interpretation, this assumption is dropped. Instead, one postulates that all characteristic scales are dynamical quantities. The question is no longer whether the universe expands into an external void, but how the internal scale of spacetime and matter evolves in a way consistent with observation.

If the scale factor evolves as

$$R(t) = R_0 e^{-Ct}, \tag{3}$$

with $C > 0$, then all characteristic lengths, periods, and volumes shrink exponentially. To an observer whose own body, clock and instruments shrink according to the same law, the universe appears static in local experiments. However, when the observer compares signals originating from distant regions and emitted at earlier times, a systematic drift in scale becomes manifest as redshift, luminosity dimming and apparent acceleration.

1.3 Toward a unified contraction framework

The contraction framework developed in this work is based on the following postulates:

1. The multiverse is infinite and composed of an infinite number of universes or domains, each governed by the same contraction principle.
2. The spacetime scale factor $R(t)$ decreases exponentially at a universal rate C, so that

$$\frac{dR}{dt} = -CR(t), \qquad R(t) = R_0 e^{-Ct}. \tag{4}$$

3. All physical scales (length, time, mass, energy density) transform proportionally with $R(t)$, making contraction locally unobservable to internal observers.
4. Radiation corresponds to oscillatory modes of contraction in the multiversal medium.
5. Gravity, inertia and other interactions can be reinterpreted as manifestations of inhomogeneities in the contraction rate and the geometry generated by these inhomogeneities.
6. Time is not a fundamental dimension but a derived parameter measuring the degree of contraction:

$$T = -\ln R(t). \tag{5}$$

Within this framework, the observed expansion of the universe is a relative phenomenon: a projection of contraction dynamics onto an interpretive grid that assumes fixed scales.

2 Theoretical Foundations

The contraction-based multiverse framework is rooted in several independent developments that challenge the standard interpretation of cosmological expansion. Although these approaches originate from different motivations, they share the idea that cosmic evolution should be understood in terms of scale dynamics rather than the expansion of space in fixed units.

2.1 Masreliez's Expanding Spacetime Theory

Masreliez proposed that cosmological redshift arises from an evolution of the scale of spacetime itself, rather than from galaxies receding in a fixed background. In his Expanding Spacetime Theory (EST), scale is a dynamical variable, and redshift is interpreted as a manifestation of scale evolution [?, 1, 2].

In the present work, we reverse the sign of Masreliez's scale evolution: instead of expansion, we postulate uniform contraction,

$$\frac{dR}{dt} = -CR(t), \tag{6}$$

which removes the need for an initial singularity and dark-energy–driven accelerated expansion.

2.2 Nottale's Scale Relativity

Nottale's Scale Relativity extends the principle of relativity from velocities to scales, asserting that there is no absolute scale any more than there is an absolute rest frame. This framework is developed in detail in Refs. [3, 4]. Physical laws must be covariant under scale transformations, including dilations and contractions. This leads to fractal structure at small scales and scale-dependent dynamics.

In the contraction framework, this provides the conceptual mechanism explaining why scale evolution is not directly observable: if the observer and the observed system both contract with the same $R(t)$, then all dimensionless ratios remain invariant.

2.3 Borchardt's Infinite Universe Theory

Borchardt argued for an infinite, non-expanding, non-singular universe. His Infinite Universe Theory explores this possibility in depth [5, 6]. Instead of a universe with a beginning, he advocated an eternal, dynamic steady state. In our model, the multiverse is infinite, and contraction does not lead to a global collapse: each domain contracts locally and proportionally, while the multiverse remains spatially unbounded.

2.4 de Haro's Lorentz-invariant Newtonian metric cosmology

De Haro constructed a Newtonian metric compatible with Lorentz invariance in the weak-field regime. A fully Lorentz-invariant Newtonian metric formulation is presented in Ref. [7]. His metric,

$$ds^2 = (1 + 2\Phi)\, dt^2 - \frac{dr^2}{1 + 2\Phi} - r^2 d\Omega^2, \tag{7}$$

bridges Newtonian gravity and General Relativity and provides a natural platform for incorporating time-dependent scale factors. By inserting $R(t)$ into the angular sector, we obtain a contraction-covariant metric that remains Lorentz compatible.

2.5 Synthesis

Combining these ingredients yields a unified picture:

- spacetime contracts isotropically at rate C,
- redshift arises from scale drift, not expansion,
- gravity emerges from inhomogeneities in the contraction field,
- the multiverse is infinite and non-singular.

3 Mathematical Model of Contraction

This section develops the basic mathematical structure of the contraction model: the evolution equation for $R(t)$, the scaling of physical quantities, and the emergence of redshift and time from contraction.

3.1 Fundamental contraction law

The central assumption is that the scale factor obeys

$$\frac{dR}{dt} = -CR(t), \tag{8}$$

with $C > 0$ constant. The solution is

$$R(t) = R_0 e^{-Ct}, \tag{9}$$

implying exponential, uniform and isotropic contraction of all physical scales.

3.2 Derived scaling laws

If a characteristic length $\ell(t)$ scales with $R(t)$, then

$$\ell(t) = \ell_0 e^{-Ct}. \tag{10}$$

Since physical clocks depend on characteristic lengths (for example, atomic periods scale with orbital radii), time intervals scale similarly,

$$\tau(t) = \tau_0 e^{-Ct}. \tag{11}$$

The corresponding frequencies increase as

$$\nu(t) = \frac{1}{\tau(t)} = \nu_0 e^{Ct}. \tag{12}$$

Volumes scale as

$$V(t) = V_0 e^{-3Ct}, \tag{13}$$

so that for a fixed comoving mass M the energy density grows as

$$\rho(t) = \rho_0 e^{3Ct}. \tag{14}$$

3.3 Redshift and time

A photon emitted at t_e with wavelength

$$\lambda_e = \lambda_0 R(t_e), \tag{15}$$

and observed at t_o with

$$\lambda_o = \lambda_0 R(t_o), \tag{16}$$

has redshift

$$1 + z = \frac{\lambda_o}{\lambda_e} = \frac{R(t_o)}{R(t_e)} = e^{-C(t_o - t_e)}. \tag{17}$$

Time can be expressed in terms of $R(t)$ as

$$t = -\frac{1}{C} \ln \left(\frac{R(t)}{R_0} \right), \tag{18}$$

and the emergent "cosmic time" variable

$$T = -\ln R(t) \tag{19}$$

serves as a logarithmic measure of cumulative contraction.

4 Metric Formulation and Geometric Structure

This section develops the geometric foundation of the contraction-based cosmology. The aim is to connect the contraction dynamics encoded in $R(t)$ to curvature, geodesics and gravitational effects.

4.1 Role of the metric in a contracting multiverse

We adopt the contraction-modified Newtonian–Lorentz metric

$$ds^2 = (1 + 2\Phi(t, r))\, dt^2 - \frac{dr^2}{1 + 2\Phi(t, r)} - R(t)^2 r^2 d\Omega^2, \tag{20}$$

where $\Phi(t, r)$ encodes local inhomogeneities and $R(t) = R_0 e^{-Ct}$ implements global contraction.

4.2 Christoffel symbols and contraction-induced acceleration

The angular term is

$$g_{\theta\theta} = -R(t)^2 r^2. \tag{21}$$

A relevant Christoffel symbol is

$$\Gamma^{\theta}_{t\theta} = \frac{\dot{R}}{R} = -C. \tag{22}$$

This implies a geometric acceleration proportional to C; contraction plays the role of a cosmic inertial field.

4.3 Curvature scalar under contraction

Using $R(t) = R_0 e^{-Ct}$, one finds

$$\dot{R} = -CR, \qquad \ddot{R} = C^2 R. \tag{23}$$

The Ricci scalar becomes

$$\mathcal{R} = 6\left(\frac{\ddot{R}}{R} + \frac{\dot{R}^2}{R^2}\right) = 12C^2. \tag{24}$$

Curvature is constant, positive and non-singular.

4.4 Geodesics in a contracting metric

The geodesic equation,

$$\frac{d^2x^\mu}{d\lambda^2} + \Gamma^\mu{}_{\alpha\beta}\frac{dx^\alpha}{d\lambda}\frac{dx^\beta}{d\lambda} = 0, \tag{25}$$

shows that:

- radial geodesics contain a contraction "drag" term proportional to C;
- angular geodesics shrink with $R(t)$, reflecting collapsing spatial circumferences;
- null geodesics preserve c, since space and time contract proportionally.

4.5 Contraction tensor and emergent time

Define the contraction tensor

$$K_{\mu\nu} = C g_{\mu\nu}. \tag{26}$$

Because $\nabla_\lambda g_{\mu\nu} = 0$, we have

$$\nabla_\lambda K_{\mu\nu} = 0, \tag{27}$$

ensuring geometric consistency.

The proper time element may be written as

$$d\tau \propto R(t)\, dt, \tag{28}$$

so that integrating yields time as an emergent measure of contraction.

4.6 Asymptotic dimensional collapse

As $t \to \infty$, $R(t) \to 0$ and spatial radii shrink to zero. Angular dimensions collapse, and the manifold becomes effectively one-dimensional. The universe approaches a purely time-like geometry without a curvature singularity.

5 Observational Implications

This section examines the observational consequences of the contraction model. Many phenomena usually attributed to expansion, dark energy or dark matter are reinterpreted as manifestations of scale drift and inhomogeneous contraction.

5.1 Redshift from contraction

As shown in Eq. (17),

$$1 + z = e^{-C(t_o - t_e)}, \tag{29}$$

so redshift directly measures the ratio of contraction between emission and observation, without requiring recession velocities or expanding space.

5.2 Luminosity distances and Type Ia supernovae

In the contraction framework, the luminosity distance behaves as

$$d_L(z) \propto \frac{1}{R(t_o)^2} d, \tag{30}$$

where d is a comoving distance. Both emitter and observer contract, so fluxes naturally dim with time, reproducing the observed SN Ia Hubble diagram without dark energy.

5.3 CMB temperature and anisotropies

Radiation temperature scales as

$$T(t) \propto \frac{1}{R(t)} = e^{Ct}, \tag{31}$$

so the CMB corresponds to the equilibrium state of a contracting medium, rather than a relic of a primordial fireball. Acoustic peaks arise from resonant oscillatory modes of contraction, and the uniformity of the CMB requires no inflation.

5.4 Baryon acoustic oscillations

BAO represent resonant modes of the contracting medium with characteristic scale

$$\lambda_{\mathrm{BAO}}(t) = \lambda_0 R(t), \tag{32}$$

providing a direct probe of the contraction rate C.

5.5 Gravitational lensing and rotation curves

Gradients in the contraction potential act as a refractive index,

$$n(r) = \sqrt{1 + 2\Phi(r)}, \tag{33}$$

reproducing gravitational lensing without dark halos. Spatial variations in the local contraction rate,

$$C(r) = C + \delta C(r), \tag{34}$$

induce effective gravitational fields

$$\mathbf{g}(r) = -R(t)\,\nabla\delta C(r). \tag{35}$$

If $\delta C(r) \propto 1/r$, then $g(r) \propto 1/r$, consistent with flat galaxy rotation curves.

5.6 Hubble tension, quasars and redshift drift

The Hubble tension arises because different data sets sample different effective epochs of contraction. Quasar light curves show no time dilation, which is naturally explained if both intrinsic periods and observational clocks co-contract. Finally, the Sandage–Loeb redshift drift test yields

$$\frac{dz}{dt} = -C(1 + z) \tag{36}$$

in the contraction model, providing a clear empirical discriminator from FLRW expansion.

6 Philosophical Implications

The contraction paradigm implies a profound shift in the interpretation of time, causality and physical reality. Time emerges from contraction, perception is invariant under scale drift, and the apparent expansion of the universe is a cognitive artifact of interpreting redshift in fixed units.

In a contracting multiverse there is no singular beginning; the multiverse is infinite and non-expanding, while individual domains contract locally. Causality emerges from the monotonic decrease of $R(t)$, and the “arrow of time” is encoded in scale rather than entropy. Conscious experience co-contracts with the universe, remaining invariant to scale drift.

7 Conclusions and Future Directions

The contraction framework provides a unified, non-singular and scale-covariant alternative to the expanding-universe paradigm. It explains major cosmological observations without invoking dark energy, inflation or singular origins, and it offers natural resolutions for several observational anomalies.

Future work includes the construction of full contraction field equations, the development of quantum field theory on a contracting background, detailed structure-formation simulations, and precision confrontation with SN Ia, BAO, CMB and redshift-drift data.

References

[1] C. J. Masreliez, "The Scale Expansion of Space—A New Cosmological Model," *Apeiron*, vol. 7, no. 4, pp. 185–207, 2000.

[2] C. J. Masreliez, "Cosmic Expansion and the Cosmic Microwave Background," *Apeiron*, 2012.

[3] L. Nottale, *Fractal Space-Time and Microphysics: Towards a Theory of Scale Relativity*, World Scientific, 1993.

[4] L. Nottale, *Scale Relativity and Fractal Space-Time*, Imperial College Press, 2011.

[5] G. Borchardt, "The Infinite Universe: A Steady-State Alternative," *Physics Essays*, vol. 1, no. 1, pp. 47–57, 1988.

[6] G. Borchardt, *The Ten Assumptions of Science: Toward a New Scientific Worldview*, iUniverse, 2013.

[7] A. de Haro, "Modified Newtonian Dynamics from a Fully Lorentz-Invariant Newtonian Metric," *Foundations of Physics*, vol. 48, pp. 1530–1550, 2018.

[8] E. Hubble, "A Relation Between Distance and Radial Velocity Among Extra-Galactic Nebulae," *Proceedings of the National Academy of Sciences*, vol. 15, pp. 168–173, 1929.

[9] A. G. Riess *et al.*, "Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant," *The Astronomical Journal*, vol. 116, pp. 1009–1038, 1998.

[10] S. Perlmutter *et al.*, "Measurements of Ω and Λ from 42 High-Redshift Supernovae," *The Astrophysical Journal*, vol. 517, pp. 565–586, 1999.

[11] Planck Collaboration, "Planck 2018 Results. VI. Cosmological Parameters," *Astronomy & Astrophysics*, vol. 641, A6, 2020.

[12] D. J. Eisenstein *et al.*, "Detection of the Baryon Acoustic Peak in the Large-Scale Correlation Function," *The Astrophysical Journal*, vol. 633, pp. 560–574, 2005.

[13] A. Sandage, "The Change of Redshift and Apparent Luminosity of Galaxies with Time," *The Astrophysical Journal*, vol. 136, pp. 319–333, 1962.

[14] A. Loeb, "Direct Measurement of Cosmological Parameters from the Redshift Drift of Distant Sources," *The Astrophysical Journal Letters*, vol. 499, pp. L111–L114, 1998.

[15] M. Milgrom, "A Modification of the Newtonian Dynamics as a Possible Alternative to the Hidden Mass Hypothesis," *The Astrophysical Journal*, vol. 270, pp. 365–370, 1983.

[16] S. S. McGaugh, "Predictions and Outcomes for the Dynamics of Rotating Galaxies without Dark Matter," *Galaxies*, vol. 8, 35, 2020.

A Appendix A: Mathematical Derivations

This appendix collects detailed derivations of the main relations used in the text: the solution of the contraction law for $R(t)$, the scaling laws for physical quantities, the computation of the Ricci scalar, and the derivation of redshift from $R(t)$.

A.1 Solution of the contraction law

Starting from

$$\frac{dR}{dt} = -C\,R(t), \tag{37}$$

we separate variables:

$$\frac{dR}{R} = -C\,dt,$$

and integrate:

$$\ln R = -Ct + \ln R_0. \tag{38}$$

Exponentiating gives

$$R(t) = R_0 e^{-Ct}. \tag{39}$$

A.2 Scaling of physical quantities

If $L(t) = L_0 R(t)$, then

$$L(t) = L_0 e^{-Ct}. \tag{40}$$

Similarly, for time intervals:

$$\tau(t) = \tau_0 e^{-Ct}, \tag{41}$$

for volume:

$$V(t) = V_0 e^{-3Ct}, \tag{42}$$

and for energy density (with fixed comoving mass M):

$$\rho(t) = \frac{M}{V(t)} = \rho_0 e^{3Ct}. \tag{43}$$

A.3 Ricci scalar

Using $R(t) = R_0 e^{-Ct}$,

$$\dot{R} = -CR, \qquad \ddot{R} = C^2 R, \tag{44}$$

the Ricci scalar of the contraction background is

$$\mathcal{R} = 6\left(\frac{\ddot{R}}{R} + \frac{\dot{R}^2}{R^2}\right) = 6(C^2 + C^2) = 12C^2, \tag{45}$$

which is constant and non-singular.

A.4 Redshift derivation

At emission:

$$\lambda_e = \lambda_0 R(t_e), \tag{46}$$

at observation:

$$\lambda_o = \lambda_0 R(t_o). \tag{47}$$

The redshift is

$$1 + z = \frac{\lambda_o}{\lambda_e} = \frac{R(t_o)}{R(t_e)} = e^{-C(t_o - t_e)}, \tag{48}$$

which reproduces the Hubble law without invoking expansion.

B Appendix B: Metric Diagram and Geometric Intuition

Global contraction can be visualised as spatial sections of radius proportional to $R(t)$ that shrink monotonically with time. A simple schematic TikZ diagram is given in Fig. 1.

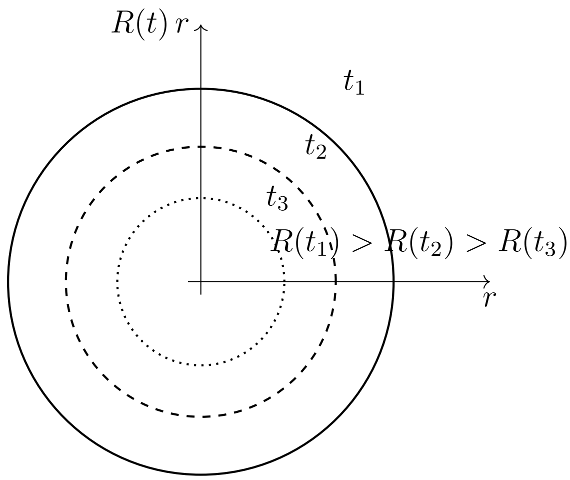

Figure 1: Schematic representation of global contraction: spatial sections at three different times $t_1 < t_2 < t_3$, with $R(t_1) > R(t_2) > R(t_3)$. The figure is purely conceptual.

This picture does not imply motion of matter "toward the origin"; instead, the metric scale factor $R(t)$ multiplies all spatial distances, causing a uniform shrinking of the geometry.

C Appendix C: Observational Data Reinterpretation

Here we summarise how major cosmological data sets are reinterpreted in the contraction framework.

C.1 Type Ia supernovae

In standard cosmology, the dimming of distant SN Ia implies an accelerating expansion driven by dark energy. In contraction cosmology, the same data are explained by the time evolution of $R(t)$, which modifies the luminosity distance and flux even in the absence of expansion. Both the source and the observer contract between emission and observation, naturally producing the observed curvature in the Hubble diagram.

C.2 Cosmic microwave background

The CMB temperature scales as

$$T(t) \propto \frac{1}{R(t)} = e^{Ct}. \tag{49}$$

The CMB is interpreted as the equilibrium radiation of the contracting medium rather than as a relic of a primordial explosion. Acoustic peaks in the angular power spectrum reflect resonant contraction modes.

C.3 Baryon acoustic oscillations

BAO correspond to characteristic scales

$$\lambda_{\mathrm{BAO}}(t) = \lambda_0 R(t), \tag{50}$$

providing a direct probe of the contraction rate C when measured as a function of redshift.

D Appendix D: Contraction Parameter and Constraints

A precise determination of the contraction rate C requires joint analysis of multiple data sets:

- SN Ia Hubble diagrams (distance moduli vs. z),
- BAO angular and radial scales,
- CMB peak locations and heights,
- local redshift-drift measurements (Sandage–Loeb test).

In principle, C is the unique cosmological parameter controlling the global rate of scale change. Deviations from a strictly constant C could signal more complex dynamics or couplings between contraction and matter content.

E Appendix E: Relation to Scale Relativity and MOND

The contraction-gradient interpretation of gravity is closely related to Nottale's Scale Relativity and to modified Newtonian dynamics (MOND).

- In Scale Relativity, physical laws are covariant under scale transformations, and spacetime becomes fractal at small scales.
- In MOND-like approaches, low-acceleration dynamics deviate from Newtonian expectations, often mimicking dark matter.

In the present framework, spatial variations $\delta C(r)$ in the contraction rate generate effective gravitational fields

$$\mathbf{g}(r) = -R(t)\,\nabla\delta C(r), \tag{51}$$

which can reproduce flat rotation curves and lensing profiles without non-baryonic dark matter. This suggests that some MOND phenomenology may emerge from underlying scale dynamics.

F Appendix F: Redshift Drift and Future Tests

The redshift drift (Sandage–Loeb effect) provides a clean, model-dependent test of cosmology. In FLRW with expansion, one has

$$\frac{dz}{dt} = (1+z)H_0 - H(z), \tag{52}$$

whereas in the contraction picture we obtain

$$\frac{dz}{dt} = -C(1+z), \tag{53}$$

which has the opposite sign for positive C.

Future ultra-stable spectrographs observing Lyman-α systems and other narrow lines over decade-long baselines will be able to measure $\frac{dz}{dt}$ directly. The sign and magnitude of the drift will discriminate decisively between an expanding ΛCDM universe and a contracting cosmology.

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