Survivorship and Coherence Cosmology

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Abstract

This paper proposes a two part reinterpretation of cosmological redshift and spectral line broadening, based on classical wave behavior rather than spacetime expansion.

First: Redshift arises from the medium itself. Light does not travel through a vacuum. Intergalactic space is filled with tenuous plasma that interacts more readily with higher frequencies. As light travels across vast distances, high frequency components are scattered or absorbed more often than lower ones. What reaches us is biased toward longer wavelengths. This is survivorship, not metric expansion.

Second: Coherence loss is a direct result of geometry in three dimensions. As wavefronts expand, their surface area grows, and each observer samples a smaller portion of the full wave. If the emitter has any instability in frequency, timing, or angle, this leads to phase variation across the observed wave. The result is line broadening and signal smearing. These effects do not require stretching of space or time. They are a natural outcome of how expanding waves behave in a structured field.

Together, these effects explain the two most persistent cosmological signatures, redshift and time dilation, without invoking expansion at all. Light doesn't just stretch. It is filtered and smeared.

Foundational Assumptions:

- There is no true vacuum.
- The speed of light is not invariant. It depends on the properties of the medium.
- Frequency is stable for coherent, continuously emitting sources
- Anything that does not interact with the electromagnetic field is undetectable and thus, by definition, unfalsifiable. Even gravity leaves electromagnetic traces.

What Is Redshift?

Redshift is simple to describe, harder to explain. We observe it when light from a distant object shows spectral lines shifted toward longer wavelengths than where we'd expect them to be. That's it. The signal might also get dimmer. Light spreads out and some of it can be scattered or absorbed along the way. But we are measuring which parts of the wavefront arrive intact, shifted, distorted, or not at all.

These shifts show up when we compare atomic fingerprints. Hydrogen, for example, emits light at very specific wavelengths when its electrons change energy states. These emission lines are well understood and easy to recognize. When we look at distant galaxies, those same lines appear but they're nudged toward the red end of the spectrum. The spacing and pattern is still there, just not where we expected them to be.

What we're measuring is a change in apparent wavelength, not necessarily speed, frequency, or motion. Just a mismatch between what was emitted and what was received. You can think of it like this: imagine hearing a familiar song through a thick wall. The melody is still there, but the pitch seems lower, and some of the higher notes didn't make it through clearly. The tune is recognizable, but it's warped. That's what happens with light. The pattern survives, but not always in its original form and not always cleanly.

This is where coherence begins to matter. Those emission lines aren't just shifted, sometimes they're smeared. Sometimes they arrive sharp and distinct, other times blurry and broken. Coherence, the internal consistency of the wave, is a second layer of information. Without it, we can't clearly resolve the wave's structure. It's not just about what parts survive, but how well they hold together.

Redshift and coherence loss often appear together. One tells us which frequencies were filtered. The other tells us how clearly the signal is arriving. Redshift tracks with how the medium filters certain frequencies. Coherence loss tracks with how instabilities are amplified geometrically with distance.

Rapidly Expanding Assumptions

In the standard model of cosmology, redshift is interpreted as evidence that the distance between galaxies is increasing. Not because the galaxies are moving through space, but because space itself is expanding. The idea is that light gets stretched along with it, like a wave painted on an inflating balloon. As that fabric expands, the wavelength of light traveling through it gets longer too. That's the premise. Redshift becomes a ruler for measuring how much space has grown since the light was emitted.

If you follow that logic in reverse, it means the universe must have once been much smaller and denser. That gives rise to the Big Bang Theory, the idea that everything began from a single, hot, dense origin. But when astronomers tried to model how structure formed after that event, the math didn't work. Galaxies and clusters couldn't have formed fast enough. So a patch was added, a brief moment of explosive early growth called inflation, which makes the early universe blow up faster than light for a tiny fraction of a second. That solved one problem, but introduced another. What powered it, and what stopped it?

Later observations implied that galaxies weren't just receding, they were accelerating away from each other. That contradicted earlier expectations. So dark energy was added, a hypothetical repulsive force built into the vacuum itself. Then to explain gravitational anomalies, dark matter was added too, another invisible ingredient to balance the equations. Time dilation became necessary as well. If the speed of light is fixed, and distances are growing, then time must be slowing down for distant observers. None of these components were predicted ahead of time. Each was introduced after the fact to make the expansion model match new observations.

Successive additions to the standard model such as inflation, dark energy and dark matter were introduced to reconcile theory with new observation. These elements, while mathematically consistent, rely on an initial interpretation of redshift as proof of expansion. Here we revisit that foundational assumption.

Rethinking Redshift

Before we accept that space itself is stretching, it's worth revisiting how waves behave in real environments. Intergalactic space isn't a vacuum. It's full of plasma, fields, and structure. Light moving through this medium experiences dispersion, attenuation, and interference. These aren't exotic effects. They're expected. That's just wave behavior.

In every field where waves are studied, acoustics, optics, electromagnetism, one pattern holds true: **higher frequencies scatter more**. They interact more readily with structure, lose energy faster, and have shorter coherence lengths. That's not speculation. That's lab tested behavior. Physicists quantify this interaction range as the mean free path, the average distance a wave travels before it scatters. For higher frequencies that path is shorter. What arrives isn't a perfect copy of what was emitted. It's a biased remnant, weighted toward lower frequencies. In Earth's atmosphere, blue light scatters more than red. That's why the sky is blue and sunsets are red. This is not controversial, its Raleigh scattering. In structured media like plasma, similar effects take place. The only difference at cosmological distances is scale. Thin structure stretched over light years adds up.
What we call redshift may not be about recession at all. It might just be survivorship.

Coherence loss is just as fundamental. As wavefronts expand, especially in three dimensions, they begin to deform. Phase relationships maintain proportionality but stretch in space. Sharp features blur. The more distance a wave travels, or the more asymmetric the emission, the more that coherence breaks down. Even in a perfectly stable medium.

Instability at the source is amplified with distance. The tiniest variations in timing, frequency, or angle become magnified across a growing wavefront. What begins as an imperceptible jitter can become a measurable smear at the observer.
The farther the wave travels, the greater the distortion. Not because the wave weakens, but because its surface area expands relative to the observer aperture. And when the signal arrives smeared, it doesn't mean time itself stretched. It means the wavefront lost coherence. That distortion isn't relative motion. It's geometry.

What Vacuum?

Light does not travel through emptiness**.** Plasma, the most abundant state of matter in the visible universe, fills the spaces between stars, galaxies, and galactic clusters. It is not uniform, but it is everywhere. Light from a distant galaxy doesn't travel through pristine emptiness. It passes through layered and numerous structures.

Every large galaxy is surrounded by a sheath of hot, ionized plasma known as the circumgalactic medium, extending hundreds of thousands of light years in all directions. Galaxy clusters are wrapped in even larger halos, millions of light years across, filled with turbulent, magnetized plasma. These are not rare anomalies, they are the default. Observations confirm them through absorption lines, X-ray emissions, and microwave scattering. In many cases, the total particle column through a single galactic halo rivals or exceeds that of Earth's atmosphere. When we look deep into space, we're not peering through a clean window. We're seeing through dozens of overlapping plasma envelopes**,** including the one that surrounds our own Milky Way. Over time and distance those structures don't just dim the light, they reshape it. And they may be more massive than we think. If baryonic matter is all that exists, much of it could be hiding in these hard to detect plasma fields. We didn't even understand the extent of our own solar sheath until Voyager passed through it. What we call missing mass may not be missing at all, just miscounted.

This brings us to the speed of light. In the standard model, C is defined as the speed of light in vacuum*.* But that's a simplification. There is no vacuum. The speed of a wavefront depends on the properties of the medium it moves through**.** In structured environments the velocity of light is not fixed. At cosmological distances however, local variations in the medium average out. The universe becomes statistically smooth at scale. Over long propagation paths, treating the speed of light as constant becomes useful again. Not because the medium is uniform, but because its irregularities cancel each other out.

None of this is new. These are standard properties of waves. The only shift here is that we're applying them to cosmology. No extra scaffolding, no exotic tweaks. Just classic wave physics, scaled up. That's it. Waves behaving like waves.

Wavelength, Frequency, and the Assumption of a Constant Speed

ƒ : Frequency **(Hz)**

Energy from a light source travels in oscillating waves. The number of oscillations per second is its frequency. For a perfectly stable emitter, this value is constant at the source.

λ : Wavelength **(m)**

Distance between successive wave peaks. This remains invariant only if the medium and the wave's frequency are constant. In astrophysics, wavelength is measured directly from spectral absorption or emission lines.

In astrophysics **we do not measure frequency directly.**

We measure wavelength and derive frequency from $c = \lambda \cdot f$

c Speed of light in a vacuum ($\approx 3x10^8 m/s$)

This equation holds true only if the wavefront travels through an empty vacuum without distortion. Over cosmic distances, this assumption breaks down. Every star, galaxy and galactic cluster is wrapped in a plasma sheath. There are large intergalactic plasma filaments. The farther out you look, the more of them you are looking through.
Each wavefront emitted by a star carries a broad spectrum of frequencies.
Low frequency components may be reflected or never leave their local star system.
High frequency components are more likely to be scattered or absorbed by plasma.
Only a filtered band of frequencies survives the full journey, and of those frequencies, some have been filtered more than others. The observed peak shifts toward lower frequencies.
When we use the measured wavelength to infer frequency, we are assuming that the full wavefront arrived intact and unchanged since emission. In reality, **what we receive is a filtered envelope of light, not the original wave.** The **carrier frequency** (the underlying oscillation rate) may remain stable, but the **observed peak wavelength** shifts due to preferential loss. This model distinguishes between the intrinsic frequency at emission and the shape of the surviving wavefront, rejecting the assumption that the two must match.

Distance and Velocity

In standard cosmology, we measure the wavelength of incoming light, assume the speed of light is fixed, and use that to back calculate the source frequency. That works if the wavefront traveled through a perfect vacuum and arrived intact. But every wavefront we receive has been filtered, sometimes heavily. In this model, we treat that distortion not as noise, but as a source of information. It tells us something real about the path the wave has taken. Sometimes, we know the distance to an object independently. If it's close enough for parallax, or part of a well mapped lensing system, or embedded in a galaxy cluster with known geometry, we treat the distance as a given. That lets us anchor the model and check our assumptions.

But most of the time, especially at cosmological distances, we don't have that kind of direct measurement. So instead of assuming redshift gives us distance, we flip the logic. Redshift itself is treated as the visible effect of selective filtering. A biased survival of certain frequencies over others. The amount and shape of that filtering reflects the amount of structured plasma the wavefront passed through. From that structure depth, we infer the distance the wave has traveled. In other words, distance isn't something we assume, it becomes a model output, reconstructed from the imprint left on the wave.

This model doesn't assume a fixed wave speed either. The speed of light is treated not as a universal constant, but as an emergent property of how a wave moves through a medium. Still, if the emitter's frequency is known, the distance is independently constrained, and the medium's behavior is understood, it becomes possible to recover an effective average wave speed from the observed data. In that case, the **wave speed is given by the product of the known emission frequency and the observed wavelength.** That value isn't built into the model; it's something we can extract, but only when the evidence allows it.

The shift here is subtle but important. In the standard model, redshift defines both distance and motion. Here, redshift is treated as a signature of interaction between the wave and its environment. We're not asking how fast something is moving. We're asking: what did the wave have to pass through to get here, and how did that journey shape what we see?

See Appendix A for discussion of distance estimation without assuming constant wave speed

Geometric Wavefront

Light can be described as a series of structured wavefronts. Shells of energy with shape, timing, and pattern that expand outward from a source. These wavefronts grow in surface area with distance, diluting intensity and magnifying any emission instabilities.

W : Wavefront

3D shell (cone or sphere) of energy, one wavelength thick, expands radially from the emitter. It embodies a complete oscillation.

Ang : Emission Angle **(radians)**

Total angular spread of the emission (spherical, conical, or beamlike)

D : Distance **(m)**

Radial separation from emitter to observer.

V : Wave Speed **(m/s)**

The effective propagation speed of the wave through the electromagnetic field. While often approximated as *c*, this value may vary with the local and cumulative field structure.

W_2 : Wavefront Surface Area **(m^2)**

Surface area of wavefront at a specified distance from emitter.

$$W_2 = 2\pi D^2\left(1 - \cos\left(\frac{Ang}{2}\right)\right)$$

W_3 : Wavefront Volume **(m^3)**

Volume of a wavefront shell; determines interaction time with observer.

$$W_3 = W_2 \cdot \lambda$$

r_o : Emitter Scale **(m)**

Radial distance from an emitter at which coherence loss becomes detectable by an observer. Serves as a reference point for comparing geometric coherence decay.

Geometric Wavefront

Here we explore what happens to intensity and coherence if the wavefront travels through a field with no medium, only geometry and internal emitter imperfections.

G_s : Geometric Scaling Ratio

Ratio of wavefront surface area at distance D to its area at emission reference scale $\mathbf{r_o}$.

Calculates geometric expansion due to radial propagation. Observer at **D** and $\mathbf{r_o}$ are assumed to be identical and share the same observational angle and orientation relative to the emitter.

$$G_s = \frac{\textit{Wavecrest Surface Area at D}}{\textit{Wavecrest Surface Area at } \mathbf{r_o}} = \left(\frac{D}{\mathbf{r_o}}\right)^2$$

σemit : Emission Instability Index

Representation of emitter instability over time. Captures deviation in:

Pulse timing **(Δt),** Frequency stability**(Δf),** Angular emission **(ΔA)**

This index is dimensionless, normalized by the baseline values t, **f** and A, and expresses the emitter's internal contribution to coherence loss.

$$\sigma emit = \sqrt{\left(\frac{\Delta t}{t}\right)^2 + \left(\frac{\Delta f}{f}\right)^2} + \left(\frac{\Delta Ang}{Ang}\right)^2$$

Instability at the source is magnified geometrically as the wavefront expands.

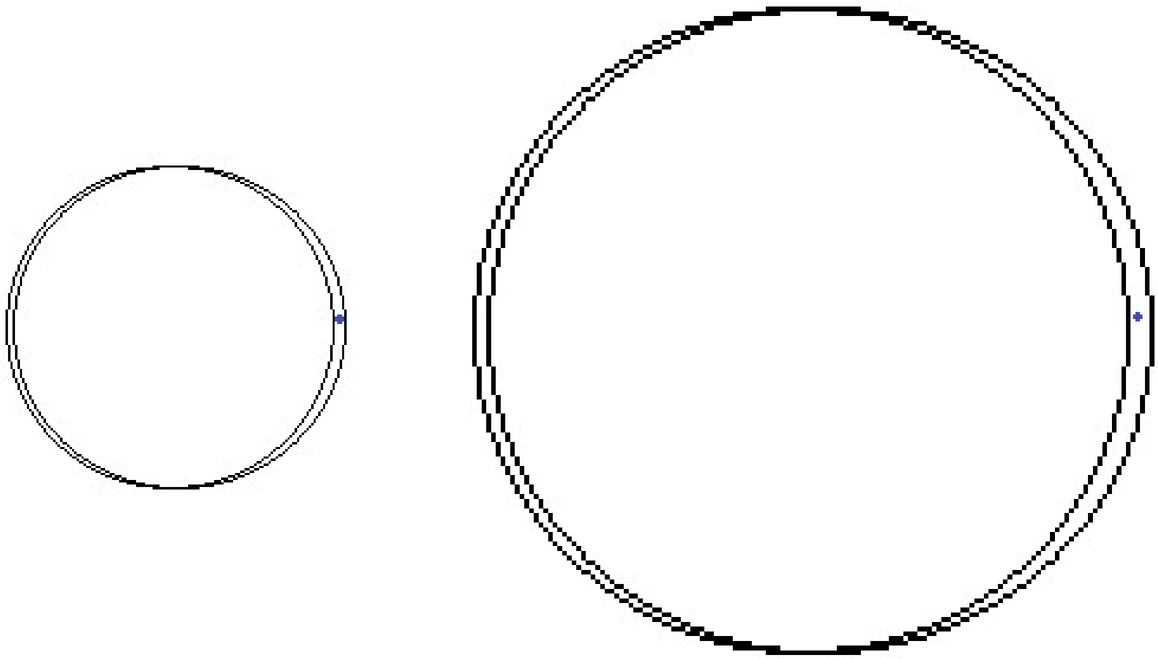
$$\textit{Coherence Degradation} = G_s \cdot \sigma emit$$

This composite term can be applied directly to any coherence sensitive metric, including spectral line width, pattern sharpness or temporal pulse spread.

A_o : Observer Aperture (m^2)

Cross sectional area of the observer detecting the wave.

Model: Coherence over Distance



Description:

Two identically shaped wavefronts are shown, one smaller and one larger, each propagating from the same emission event. The tiny blue dot represents an observer of fixed aperture.

Interpretation:

The small circle represents a wavefront observed at a relatively short distance. The observer aperture $\mathbf{A_o}$ spans a large fraction of the total wavefront, so it receives a highly coherent signal with minimal distortion.

The large circle represents the exact same wavefront expanded to a much greater distance. The observer aperture is now sampling a much smaller fraction of the wavefront. Even small emission instabilities or imperfectly stacked wavefronts are amplified geometrically at this scale. This illustrates how apparent redshift may arise from observing the same event at varying distance.

> This model treats coherence loss primarily as a function of geometric wavefront expansion and source instability. For simplicity, and because we only have one vantage point, we have not taken into account the observers position relative to the vector of emission. In the above example, you will note that an observer at the top or bottom of the wavefront would not perceive the same emission instability as the observer to the left or right.

Intensity over Distance

In this model, observed intensity at distance **D** falls off inversely with the geometric scaling ratio $\mathbf{G_s}$**,** which tracks the growth of the wavefront's surface area. Before applying any medium based attenuation or coherence degradation, we define the base intensity falloff as:

$$\mathbf{I\ geo} = \frac{\mathbf{I_o}}{\mathbf{G_s}} \qquad \textbf{or} \qquad \mathbf{I\ geo} = \mathbf{I_o} \cdot \left(\frac{\mathbf{r_o}}{\mathbf{D}}\right)^2$$

This is not the final observed intensity, only the energy falloff due to wavefront expansion.

$\mathbf{I_{geo}}$	Intensity at distance D, after geometric dilution alone
$\mathbf{I_o}$	Reference intensity at distance $\mathbf{r_o}$, including local Doppler and gravitational effects. These become increasingly negligible at large distances, where medium filtering and geometric dilution dominate the observed signal.

Note on Supernovae and Gamma Ray Burst Time Dilation:

Supernovae and gamma ray bursts are not continuous emitters, they are one shot bursts. They do not have a carrier wave or steady oscillations to support a stable light envelope. Once the wavefront leaves, there's nothing reinforcing it. What we receive is a transient pulse expanding across space with no continuous impulse, no frequency with which to maintain a consistent wavelength. This isn't exotic, it's basic wave behavior. In acoustics, we see the same with a short impulse. It spreads, it softens, and its peak flattens.

The stretched rise and decay times we observe in distant supernovae and gamma ray bursts are due to the same classic wave physics: not time dilation, just the natural consequence of a onetime event expanding geometrically.

See Appendix B for discussion of time dilation effects in Supernovae

Redshift as Survivorship Bias

In this model, the observed wavelength spectrum is a filtered remnant of the original wavefront. We do not assume the observed spectrum represents an undistorted signal. High frequency components are more likely to be scattered during propagation.

We only measure wavelength directly. We reject the assumption that light travels unchanged through vacuum. **C** is treated as a local approximation, not a universal constant.

α : Attenuation Coefficient

Describes how strongly the medium filters out a given wavelength. Shorter wavelengths are more strongly attenuated than longer ones. This is modeled as a power law relationship

$$\boldsymbol{\alpha = \alpha_0\left(\frac{\lambda_0}{\lambda}\right)^{n}}$$

We define the **Survivorship S** at a given wavelength as the fraction of the original intensity that remains after travelling distance D through a filtering medium. If **S < 0 it is set to 0.** This creates a wavelength dependent filter that shifts the surviving spectrum to the red.

$$\boldsymbol{S = 1 - \alpha \cdot D}$$

Negative values of S are clamped to zero

$\boldsymbol{\alpha_0}$	Reference Attenuation coefficient	(1/Mpc)
λ_0	Reference Wavelength used for scaling	(m)
n	Power law index (controls attenuation curve)	
Iobs	Final observed intensity at wavelength λ as observed at distance **D** after geometry and filtering.	(1/Mpc)

$$\boldsymbol{Iobs = Igeo \cdot S}$$

$$\boldsymbol{Iobs = I_o \cdot \left(\frac{r_o}{D}\right)^2 \cdot \left[1 - \alpha_0\left(\frac{\lambda_0}{\lambda}\right)^{n} \cdot D\right]}$$

Redshift as Survivorship Bias

Redshift arises here not from recessional velocity, but from the wavelength dependent survivorship of the original emission. As high frequency components are progressively filtered out, the peak of the observed intensity spectrum shifts toward longer wavelengths.

The observed peak wavelength, $\lambda_{\mathbf{obs,peak}}$, is the wavelength at which the filtered wavefront's intensity, described by $\mathbf{I_{obs}}$, reaches its maximum. This intensity curve accounts for both geometric dilution and medium dependant attenuation. This peak is not fixed, it shifts as higher frequency components are lost to filtering. The resulting wavelength that we observe, the redshift, is the result of how that combined filtering shapes the spectrum.

We define the apparent redshift as the relative shift between the unfiltered source peak and the peak of the filtered intensity envelope.

$$\boldsymbol{Z\ apparent} = \frac{\lambda_{\mathbf{obs,peak}} - \lambda_{\mathbf{emit,peak}}}{\lambda_{\mathbf{emit,peak}}} = \frac{\lambda_{\mathbf{obs,peak}}}{\lambda_{\mathbf{emit,peak}}} - 1$$

$\mathbf{Z_{apparent}}$ Apparent redshift caused by spectral distortion, not motion

$\lambda_{\mathbf{emit,peak}}$ True peak wavelength of the unfiltered source spectrum, corrected for Doppler and gravity.

$\lambda_{\mathbf{obs,peak}}$ Peak wavelength of the surviving intensity curve after geometric and wavelength dependent filtering.

In Summary

Apparent Redshift in this model represents selective survivorship. Different wavelengths are filtered differently as they move through space. As a result, the peak of the observed intensity spectrum shifts toward longer wavelengths over distance. This isn't a stretch of a wave's internal timing, it's a shift in what part of the signal makes it through. The redshift we see is the **residue** of what survives. This effect is quantified by multiplying the **Igeo, the geometric wavefront intensity dilution** by the **Survivorship** function:

$$\boldsymbol{Iobs} = \mathbf{I_o} \cdot \left(\frac{\mathbf{r_o}}{\mathbf{D}}\right)^{\mathbf{2}} \cdot \left[\mathbf{1} - \boldsymbol{\alpha}_0\left(\frac{\lambda_0}{\lambda}\right)^{\mathbf{n}} \cdot \mathbf{D}\right]$$

$\boldsymbol{\lambda_o}$ Reference wavelength (500 nm for the Sun)

$\boldsymbol{\lambda}$ Wavelength under consideration

The farther the wave travels, the more heavily filtered it becomes, and the more the apparent peak shifts. It's not time dilation. It's not recession. It's survivorship bias.

Spectral Line Broadening is a separate phenomenon. Even if a part of the spectrum makes it to the observer, its clarity and structure depend on how coherent the wavefront still is when it arrives. This is driven by geometric coherence loss. As the wavefront expands, any small instability at the emitter gets amplified. The larger the wavefront, the more the internal phase structure breaks down, especially if the source itself was unstable. This degradation doesn't shift the peak, it smears the features. Spectral lines that were sharp at the source become fuzzy or spread out at the observer, even if the peak remains in the same location. We express this qualitatively as:

$$\boldsymbol{Coherence\ Degradation} = \boldsymbol{G_s} \cdot \boldsymbol{\sigma emit}$$

The broader the wavefront and the more unstable the emission, the worse the coherence. In this model, redshift and broadening are **independent**. A cleanly shifted spectrum can still be sharp, and a smeared one might not be shifted much at all. This **decoupling** is a key difference from Doppler or metric based models.

Predictions

Time Dilation in Transients Is Geometric

Apparent stretching of light curves in supernovae and gamma ray bursts results from wavefront flattening in 3D space, not relativistic time dilation.

Test: Pulse envelopes stretch with distance, even in lab-scale analogs, without invoking spacetime expansion.

Pulsars Show No Time Dilation

Coherent, periodic sources retain intrinsic timing across distance. Without wavefront flattening or instability, there is no temporal distortion.

Test: High redshift pulsars show pulse spacing within the normal emission range of nearby ones. (With the exception of local Doppler or gravitational effects)

Stretching and Smearing Co Scale Beyond Thresholds

Temporal dilation (T_0) and spectral broadening (r_0) arise from different geometric thresholds. If both are crossed by a transient, coherent emitter, their observed effects scale proportionally from that point forward.

Test: For emitters with low **σemit** and known light curve shape, the ratio between temporal stretching and spectral smearing remains constant at increasing distance.

Redshift and Coherence Are Independent

Redshift arises from wavelength dependent survivorship. Coherence loss arises from geometric magnification of source instability.

Test: Equal redshift sources show different spectral sharpness.
High redshift stable emitters retain sharp lines.
Nearby unstable sources may smear without redshift.

Predictions

Frequency and Wavelength Decouple

In coherent sources, the carrier frequency can remain stable while the observed wavelength shifts due to survivorship filtering. The equation $c = \lambda \cdot f$ no longer holds across distance in structured media. This is conceptually similar to chirp amplification where the wave is stretched, except then only the lower portion gets returned. The carrier remains unchanged, but the envelope appears redshifted due to preferential loss.

Test: Use heterodyne (beat frequency) methods to compare frequency directly to observed spectral wavelength in distant coherent sources.

Model Improves with Distance

Over large distances, survivorship filtering dominates and local variability averages out. Predictions become more reliable at cosmological scale.

Test: High redshift objects align more closely with model expectations than nearby sources with local structure noise.

Appendix A: Distance Without Assuming a Fixed Speed of Light

We don't know the wave speed out there. Light moves through a complex medium and we don't yet have an accurate map of that medium. Speed is not something we can just plug in. That means if you're trying to get distance from redshift, the standard framework is insufficient. We cannot assume a constant speed and back calculate. But we don't have to. There are ways to estimate distance without relying on a fixed velocity at all. They don't give perfect answers, but they give meaningful constraints. Below are five methods that still let us get a grip on distance.

Parallax

Close stars shift slightly as Earth orbits the Sun. That angular shift gives distance directly. Its rock solid, but limited in range. Past a few thousand light years, the angle gets too small to resolve reliably.

Standard Candles

Objects like **Type Ia supernovae**, **Cepheid variables**, and **RR Lyrae stars** have well known brightness curves. If you know how bright it should be, and it looks dimmer, it's farther away. You don't need to assume how fast the light traveled, just how much of it made it here. Intensity is admittedly complicated by the intervening medium, however it can reasonably provide us with a lower bound on distance.

Supernova Wavefront Stretching

In the case of Ia Supernovae we have more precision. Supernovae are not carrier waves, they are single events. Treating these events the same way we would a continuous stable emitter is a category error. In this model, that means the wavefront expands and flattens as it travels. These events follow a predictable light curve that takes 20 to 30 days to play out. The amount of time it takes for us to observe this expected light curve allows us to directly calculate distance due to the geometric expansion of the transient wavefront.

Appendix A: Distance Without Assuming a Fixed Speed of Light

Megamasers and Orbital Velocities

Megamasers offer a rare opportunity to estimate distance and wave speed using only internal geometry. These systems are bright, coherent, and often trace clean, rotating disks around central masses like black holes. If we can resolve both sides of a maser disk and observe the redshifted and blueshifted regions, track their frequency drift over time, and measure the disk's angular size on the sky, we can build a dynamic picture of the system from the inside out.

What's unusual about this method is that it doesn't require us to assume a fixed value for the speed of light. Instead, we track how fast the system appears to be moving based on frequency shifts and how quickly those shifts change. Combine that with the apparent angular spread, and you have the full geometry of the orbit. From there, you can solve for either the distance to the system or the wave speed within it, whichever one you didn't already know.

In most cosmological frameworks, distance is something you infer from redshift using an assumed expansion rate and an assumed constant **c**. But here, distance and **c** are tied together geometrically. If you anchor one, you can solve for the other. That's what makes masers so powerful in this model. They don't just tell you how far away something is. They give you a direct window into how fast waves actually move through that region of space. This method doesn't require expansion, standard candles, or a fixed speed of light. It only requires structure. A future companion paper will present the full derivation, along with real maser data used to back calculate local wave speed in distant systems. The goal is to treat **c** not as an axiom, but as an observable, and to map how it may vary across different field environments.

Appendix A: Distance Without Assuming a Fixed Speed of Light

Redshift as a Distance Proxy

This model doesn't treat redshift as proof of recession. It treats it as preferential filtering**.** Higher frequencies get stripped out more quickly as light moves through structured plasma. That filtering builds with depth. So over large averages, redshift still tracks with distance, not because of Doppler motion, but because of survivorship. That relationship is still useful, just interpreted differently.

Putting It Together

In this model, distance is not something we assume. It's something we cautiously infer, and always with context. We don't start by saying how fast light should travel or how much space has stretched. We start by asking what made it here, what didn't, and what shape the surviving wavefront still holds.

Each method we use provides us a different kind of clue. No single one provides a perfect distance on its own. But together, they let us cross check. If multiple approaches converge on the same ballpark, we gain confidence. If they diverge, we learn something about the structure of the medium itself.

What matters is that we stop treating distance as a context free function of redshift and constant velocity. Instead, we let it emerge from structure: from wavefront shape, angular scale, geometric dilution, and survivorship filtering. The more constrained our inputs, and the more independent our anchors, the more reliably we can use those signals to reconstruct how far the wave had to go. This framework doesn't claim perfect precision. But it does offer a path toward treating distance as a value derivable from wave behavior.

Appendix B: Temporal Stretching and Coherence in Type Ia Supernovae

In this model, redshift, time dilation, and coherence decay are not all bundled together. They are distinct effects, even if they show up at the same time. Type Ia supernovae put this to the test better than just about anything else.

Temporal Stretching: Light curves from Type Ia events get longer with distance. Nearby ones might last 20 days, faraway ones may stretch 50 or more. The standard model calls this relativistic time dilation from universal expansion. This model suggests that the wavefront **physically stretches**, geometrically, as it travels. There's no continuous carrier wave to maintain a consistent wavelength over distance.

Spectral Coherence: Despite that stretching, the spectral features stay razor sharp. Spectral lines don't smear or blur much. This implies an extremely coherent and clean initial wavefront.

These two observations are not contradictory. Stretching in time can happen without spectral broadening. A single burst without ongoing emission support should stretch out over distance. But if it was emitted extremely cleanly, it can stay spectrally sharp anyway. The waves can still be clean, shaped right, each the same size as the other, but be proportionally larger relative to a distant observer. Observationally, that means the light curve takes longer to pass by.

Imagine dropping a spherical boulder into a perfectly still pond. The event takes a finite amount of time to unfold, and the wavefront that it creates is structured and extremely uniform. To a nearby observer the entire wavefront event passes by quickly. To a faraway observer, the time it takes for the full wavefront to pass by is much longer. If one were to drop identical boulders in the exact same place at a set rate, the faraway observer would also view each wavelength as being identical to the nearby observer. This is the conceptual difference between a steady continuous emitter like a star and a onetime burst event like a supernova.

Appendix B: Temporal Stretching and Coherence in Type Ia Supernovae

To formalize this, we introduce a second threshold: $\mathbf{T_0}$, the radial distance at which temporal stretching becomes measurable for a transient, non periodic burst.

T_0 plays the same role for burst duration that R_0 (the geometric coherence threshold) plays for coherence. They mark the distance at which **geometry alone** introduces measurable change: wave flattening ($\mathbf{T_0}$) and angular dispersion ($\mathbf{r_0}$). The math is the same. What we are measuring changes.

For $\mathbf{r_0}$**,** it's wavefront coherence, spectral width and intensity loss.

For $\mathbf{T_0}$**,** it's event duration and wavefront depth.

This framework explicitly decouples temporal duration from spectral broadening, allowing one to scale without the other. Future work will look at how to predict $\mathbf{T_0}$ values based on emission class and geometry, and whether we can measure both thresholds ($\mathbf{T_0}$ and $\mathbf{r_0}$) from existing data without assuming cosmological expansion.

One striking observational alignment with this framework comes from Type Ia supernovae. These events show significant temporal stretching at high redshift but no measurable spectral coherence loss, even at cosmological distances.

In this model, that's not surprising. Type Ia explosions are extraordinarily coherent at emission, with a vanishingly small **σemit**. While they clearly cross the threshold for geometric time stretching ($\mathbf{T_0}$), they **never cross** $\mathbf{r_0}$, because their coherence is too high to measurably degrade at observable distances, even after massive geometric amplification.

This explains why Type Ia light curves stretch while remaining spectrally sharp. It's not relativistic time dilation. Its clean geometric flattening of a stable wavefront, and it proves that $\mathbf{T_0}$ and $\mathbf{r_0}$ can be separated in practice. The stretching and the smearing come from the same geometry, but they act on different features, at different thresholds, and are not required to show up at the same distance.

Appendix C: A Note on the Cosmic Microwave Background

This model does not require the CMB to function, nor does it seek to reinterpret its origin in detail. The goal here is not to replace the standard CMB narrative, but to demonstrate that a coherent redshift and coherence model can be built without invoking it in at all.

The observed microwave background may be the integrated result of long distance scattering and equilibrium filtering through structured plasma.
In this view, the CMB is not a leftover flash from a hot origin, but a natural byproduct of universal structure at scale.

This model makes no prediction about specific CMB anisotropies or acoustic peaks. That task is reserved for future work, should the survivorship framework be extended to longer wavelength coherence environments. This appendix exists only to make clear: the model presented here neither requires nor rejects the CMB. It simply does not depend on it.

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Submitted to Zenodo on July 28, 2025

10.5281/zenodo.16555399

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