Cosmological Redshift Without Expansion: The Quarkbase Cosmology Explanation

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Abstract

The cosmological redshift is commonly interpreted within standard cosmology as a geometric effect arising from the expansion of space. In the absence of a physical medium, this interpretation ultimately reduces the observed frequency shift to a global rescaling of the mathematical norm used to define distances and times. In this work, we present an alternative and fully physical interpretation of cosmological redshift within the framework of Quarkbase Cosmology.

Quarkbase Cosmology postulates a continuous physical medium, the Ψ-field, from which spacetime phenomena emerge. Light is described as a non-dissipative luminal resonant mode of this medium, while frequency is treated as a local, operational quantity determined by the coupling between material resonators and the surrounding Ψ-field. Within this framework, the cosmological redshift is shown to arise from the difference between the physical state of the medium at the points of emission and observation, rather than from kinematic recession or metric expansion.

The entire phenomenon is captured by a simple operational law,

$$1 + z = \frac{n(t_{\mathrm{obs}})}{n(t_{\mathrm{emit}})}.$$

where $n(t)$ is an effective propagation index characterizing the state of the Ψ-field. This interpretation naturally accounts for the observed redshift–distance relation without invoking expanding space, accelerated dynamics, or dark energy. The tri-regime structure of the Ψ-field provides the large-scale architectural context for cosmic evolution but is shown not to be the direct cause of spectral shifting.

Cosmological redshift is thus reinterpreted as a direct physical probe of the temporal evolution of the universe's underlying medium, rather than as evidence for global geometric expansion.

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1 Conceptual reset: what redshift can and cannot mean

1.1 What "expansion" means in standard cosmology

In standard cosmology there is, by construction, **no physical medium** underlying space. There is no ether, no substrate, no material support of propagation.

Consequently:

- there is no "something" between galaxies,
- there is no substance that could physically dilate,
- there is no material reference frame filling space.

When standard cosmology speaks of *expansion of space*, it therefore **cannot** be referring to the expansion of any physical entity.

The only object that can consistently "expand" under these assumptions is:

the mathematical norm that defines distances and durations.

Equivalently stated:

- the rule used to measure distances is rescaled,
- the spacetime metric is globally re-normalized,
- the correspondence between coordinates and observables is modified.

Stated without metaphor:

what expands is the norm of measurement, not a physical content.

This is not an interpretation imposed from outside; it is the only option logically compatible with a theory that explicitly denies the existence of any underlying medium.

1.2 Why "the space between galaxies" cannot expand by itself

This point is usually left implicit, yet it is unavoidable.

If space is not a physical entity, then:

- it cannot expand "only between galaxies",
- it cannot grow in some regions and not in others,
- there cannot be local voids that dilate while the rest remains unchanged.

Any putative expansion must therefore be:

- homogeneous,

- global,
- proportional everywhere.

This immediately forces the conclusion that, within standard cosmology, expansion cannot describe a local physical process. It can only describe a **global rescaling of the algebraic structure used to define spatial and temporal intervals**.

This is not a philosophical preference; it is a **direct consequence** of denying the existence of an ether or medium.

At this stage, the standard framework has already committed itself: expansion is a property of the **mathematical description**, not of a physical substance.

1.3 Why norm expansion alone cannot account for redshift

There exists no demonstration showing that a homogeneous expansion of the norm of measurement can produce an observable cosmological redshift.

In standard cosmology, the redshift is not derived from a physical expansion, nor from an operational rescaling of units. Instead, it is introduced directly as a property of dynamical metric solutions. The effect is not explained in physical terms; it is encoded geometrically.

In the absence of a physical medium, such a codification does not identify any mechanism responsible for the observed frequency shift.

1.4 Why Quarkbase does not inherit this ambiguity

Quarkbase Cosmology does not inherit the ambiguity described above because it **does not start from a geometric vacuum**. Its foundational assumption is different: spacetime phenomena emerge from the dynamics of a physical medium, the Ψ-field.

This single ontological choice immediately fixes what remains undecidable in standard cosmology.

In Quarkbase:

- there **is** a medium filling space,
- propagation occurs **in** that medium,
- clocks and rulers are **physical systems coupled to it**,
- and light is a specific, non-dissipative resonant mode of the medium itself.

As a consequence, concepts that are ambiguous in a purely geometric framework become physically anchored. When a frequency changes, the theory does not have to choose between "geometry" and "measurement convention": the change is attributed to the **state of the medium** at the point where the frequency is generated or measured.

In particular, Quarkbase does not need to ask whether "space expands" or whether "the metric rescales". Those questions only arise in the absence of a medium. Once a physical substrate is present, there is no reason to inflate an abstract norm to account for an observable effect that can be traced to material conditions.

The cosmological redshift therefore admits a direct physical reading:

- the emitted frequency depends on the local state of the Ψ-field at the emitter,

- the observed frequency depends on the local state of the Ψ-field at the observer,
- the difference between the two is measured as redshift.

No additional interpretative layer is required.

Crucially, this does **not** reintroduce any preferred frame or violate relativistic invariance. In Quarkbase, relativistic invariance is an **emergent symmetry** of the Ψ-field dynamics, not a postulate imposed on an empty background. The luminal mode defines the invariant propagation speed, while the medium's state determines how local resonators couple to that mode.

Thus, what appears as a geometric ambiguity in standard cosmology is resolved in Quarkbase by construction: the theory assigns physical meaning to the quantities that generate observables, rather than absorbing them into a rescaled metric.

This is why Quarkbase can treat the cosmological redshift as a **material phenomenon** without invoking expanding space, changing rulers, or ambiguous metaphors.

2 Physical definitions in Quarkbase Cosmology

2.1 What light is

In Quarkbase Cosmology, light is not treated as a fundamental particle nor as an abstract excitation propagating through empty space. Light is the **luminal resonant mode of the Ψ-field**, the physical medium that underlies all interactions.

This luminal mode has three defining properties:

- it propagates without dissipation,
- it preserves phase coherence over cosmological distances,
- it fixes the invariant propagation speed (c) as an emergent property of the medium.

Light is therefore a **collective dynamical mode** of the Ψ-field. It does not require a background spacetime to exist independently of the medium, nor does it "move through" space as an entity detached from its environment. Instead, it is a self-sustained periodic reorganisation of the medium itself.

Because the luminal mode is non-dispersive and frictionless, its propagation does not degrade energy or coherence. Any interpretation of cosmological redshift that relies on gradual energy loss, scattering, or absorption is therefore incompatible with the Quarkbase description of light.

2.2 What frequency is

Within this framework, frequency is **not an intrinsic attribute carried by the wave independently of observers**. Frequency is a *local operational quantity*.

More precisely, frequency is:

> the rate at which a local material resonator—an atom, molecule, or clock—oscillates when coupled to the luminal mode of the Ψ-field.

This definition has an important consequence: frequency is not a property of light alone. It is a relational quantity that depends on both the propagating mode and the physical state of the resonator that interacts with it.

Atoms do not emit light “in vacuum”. They emit while embedded in the Ψ-field, and their characteristic transition rates depend on the local state of that field. Likewise, detectors do not measure an abstract oscillation; they register transitions of physical systems whose internal dynamics are set by their coupling to the same medium.

Thus, a change in observed frequency does not necessarily imply a change in the wave during propagation. It may equally reflect a change in the physical conditions under which emission or detection occurs.

2.3 What is actually measured

A redshift measurement consists of a **dimensionless ratio**:

$$1 + z \equiv \frac{\nu_{\text{emit}}}{\nu_{\text{obs}}}.$$

Operationally, this ratio compares:

- a frequency defined by a resonator at the emission event,
- a frequency defined by a resonator at the observation event.

No direct information about the intermediate propagation is contained in this ratio by itself. The measurement does not encode whether the wave lost energy, whether space expanded, or whether the emitter moved. It only states that two local clocks, coupled to the Ψ-field under different conditions, ran at different rates relative to the same luminal mode.

In standard cosmology, this ratio is embedded into a geometric interpretation by assigning it to a changing metric. In Quarkbase Cosmology, the same ratio is interpreted directly as a comparison between two **states of the physical medium**.

This distinction is decisive. Once frequency is recognised as a local, medium-coupled quantity, the cosmological redshift ceases to be a geometric mystery and becomes a probe of the large-scale evolution of the Ψ-field.

3 The physical origin of cosmological redshift in Quarkbase Cosmology

3.1 The central physical principle

In Quarkbase Cosmology, the cosmological redshift is neither a kinematic effect nor a geometric one. It is a **material effect** arising from the evolution of the physical medium that defines both light propagation and local measurement.

The central principle can be stated unambiguously:

> **The frequency measured for a luminal mode depends on the physical state of the Ψ-field at the point of emission and at the point of observation.**

This statement immediately removes the need for auxiliary hypotheses. No appeal is made to expanding space, changing rulers, or global recessional velocities. The redshift reflects a difference between two local physical conditions, not a deformation of an abstract background.

3.2 The propagation index of the Ψ-field

The interaction between the luminal mode and the Ψ-field can be summarized by a single scalar quantity: an effective **propagation index** (n).

This index does not describe dissipation or dispersion. Instead, it characterizes how the local state of the medium couples to oscillatory processes, including atomic transitions and clock rates. Changes in (n) correspond to changes in the medium's response, not to losses of coherence or energy.

Crucially:

- the luminal mode remains coherent,
- the invariant propagation speed (c) is preserved,
- no frequency-dependent scattering is introduced.

The index (n) is therefore not an optical refractive index in the conventional sense, but an **operational index** that encodes how the Ψ-field sets the scale of temporal oscillations.

3.3 The redshift law in Quarkbase Cosmology

With these definitions in place, the cosmological redshift follows directly.

Let $n(t_{\text{emit}})$ denote the propagation index of the Ψ-field at the spacetime event where light is emitted, and $n(t_{\text{obs}})$ the corresponding index at the observation event. The redshift is then given by the simple and exact relation:

$$1 + z = \frac{n(t_{\text{obs}})}{n(t_{\text{emit}})}.$$

This equation contains the full physical content of cosmological redshift in Quarkbase Cosmology.

It states that the redshift measures the relative change in the coupling between the luminal mode and local resonators between emission and observation. No intermediate stretching of the wave, no loss of energy, and no expansion of space are implied or required.

3.4 Interpretation and scope

Several immediate consequences follow from this law.

First, the redshift is **set at emission and observation**, not accumulated as a dissipative process during propagation. The wave does not gradually "redden" as it travels; rather, the same coherent mode is sampled by resonators operating under different medium conditions.

Second, the redshift is fundamentally **achromatic** at leading order. Since $n(t)$ characterizes the medium globally and not specific wavelengths, the redshift applies equally to all frequencies of the luminal mode, in agreement with the primary observational fact that cosmological redshift is largely wavelength-independent.

Third, the familiar empirical relation between redshift and distance arises naturally. Distance acts as a proxy for lookback time: more distant sources are observed at earlier epochs, when the Ψ-field was in a different state, corresponding to a different value of $n(t)$. The distance itself is not causal; it merely labels the temporal separation between emission and observation.

3.5 Conceptual contrast with standard cosmology

In standard cosmology, the same observational ratio $(1 + z)$ is embedded into a geometric framework by identifying it with the ratio of scale factors $a(t_{\mathrm{obs}})/a(t_{\mathrm{emit}})$. In Quarkbase Cosmology, the ratio is instead identified with the evolution of a physical medium parameter.

Mathematically, the two descriptions may be formally mapped onto one another. Physically, they are radically different. One inflates a geometric norm in the absence of substance; the other tracks the evolution of a real medium whose state directly affects measurable quantities.

This distinction is not semantic. It determines whether cosmological redshift is interpreted as evidence of global kinematics or as a probe of the physical structure of the universe.

4 Why redshift increases with distance without expansion

4.1 Distance as a marker, not as a cause

Within Quarkbase Cosmology, the empirical correlation between redshift and distance does not encode a dynamical recession of objects. It encodes a **temporal ordering** of emission events.

Light from a distant source is observed as it was emitted at an earlier cosmic time. Distance therefore functions as a **label of lookback time**, not as a causal agent. The observed monotonic increase of redshift with distance simply reflects the fact that the propagation index $n(t)$ of the Ψ-field has evolved over cosmic history.

In this framework, the statement "more distant objects are more redshifted" translates directly into:

> **objects observed at earlier epochs were embedded in a Ψ-field with a different state parameter $n(t)$.**

No kinematic interpretation is required to account for this ordering.

4.2 Why no velocity field is implied

Standard cosmology often introduces a velocity field to rationalize the redshift–distance relation, typically expressed as a proportionality between recession velocity and distance. In Quarkbase Cosmology, this step is neither necessary nor meaningful.

Redshift measurements do not determine velocities. They determine ratios of frequencies measured by local clocks. Assigning those ratios to velocities requires an additional interpretative layer that presupposes either:

- moving sources in a fixed background, or
- expanding geometry in the absence of a medium.

Quarkbase adopts neither premise. The Ψ-field provides a physical reference that renders velocity assignments superfluous. The redshift is fully accounted for by the temporal evolution of the medium's state, without invoking relative motion between emitter and observer.

4.3 Why acceleration is not required

A frequent source of confusion arises from analogies with Doppler effects in ordinary media. In such analogies, an increasing redshift with distance is interpreted as evidence that more distant sources must be receding faster, and therefore accelerating.

This reasoning does not apply here.

In Quarkbase Cosmology, the redshift–distance relation is not interpreted as a sequence of velocities sampled along a trajectory. It is interpreted as a comparison between emission events embedded in different historical states of the Ψ-field. The monotonicity of redshift with distance reflects the monotonic evolution of $n(t)$, not an acceleration of matter.

There is therefore no sense in which a galaxy must "speed up" as it becomes more distant. Distance does not represent a stage of motion; it represents a depth in cosmic time.

4.4 The observational content of the redshift–distance relation

The observable fact is minimal: spectral lines from more distant sources appear systematically shifted toward lower frequencies. This fact alone constrains only one thing—the ratio of the operational frequency scales at emission and observation.

In Quarkbase Cosmology, this constraint is read directly as information about the time evolution of the Ψ-field. The redshift–distance relation becomes a probe of how the medium's state parameter $n(t)$ has changed over cosmic history.

No inference about expansion, acceleration, or global kinematics follows from this relation alone. Those interpretations belong to a geometric framework that Quarkbase does not assume.

4.5 Emergent agreement with observations

Although Quarkbase Cosmology rejects expansion as a physical mechanism, it does not reject the observational regularities usually associated with it. The smooth increase of redshift with distance, the large-scale isotropy of observations, and the coherence of spectral shifts across wavelengths all follow naturally from a globally evolving medium.

In this sense, Quarkbase reproduces the empirical successes of standard cosmology while assigning them a different physical origin. The same data are explained without invoking expanding space, accelerated recession, or additional unseen entities.

5 The role of the tri-regime structure of the Ψ-field

5.1 Definition of the tri-regime behaviour

Quarkbase Cosmology attributes to the Ψ-field a **tri-regime physical behaviour**, not as a function of distance from the observer, but as a function of the **characteristic volume of the structure involved**.

This distinction is essential.

The Ψ-field is always present and always perceived locally as a plasma-like medium. Its regime does **not** depend on where the observer is located, nor on how far away an object lies. Instead, the effective macroscopic behaviour of the field depends on the ratio between:

- the total volume of the structure under consideration,
- and the characteristic interaction volume of the Ψ-field modes.

Operationally, this yields three regimes:

- **plasma-like behaviour** for structures up to galactic scales,
- **fluid-like behaviour** for systems extending from galaxies to clusters,
- **gas-like behaviour** for supercluster-scale structures.

These regimes describe how the Ψ-field responds collectively to large-scale organization. They are intrinsic properties of the medium and are, in principle, observable through independent phenomena.

5.2 What the tri-regime structure does explain

The tri-regime structure plays a crucial role in Quarkbase Cosmology, but its role is often misunderstood if not stated explicitly.

It governs:

- the stability of large-scale structures,
- the coherence of collective modes at different scales,
- the transition between localized and distributed dynamics,
- the emergence of filamentary and hierarchical cosmic organization.

In other words, the tri-regime behaviour explains **how matter and the Ψ-field organize themselves across scales**, not how frequencies are shifted between emission and observation.

It provides the **structural background** against which cosmological processes unfold.

5.3 What the tri-regime structure does *not* explain

It is essential to state just as clearly what the tri-regime structure does *not* do.

The tri-regime behaviour of the Ψ-field is **not** the causal mechanism behind the cosmological redshift.

Specifically:

- redshift does not arise because light enters a different "phase" as it travels,
- it does not accumulate through successive plasma–fluid–gas transitions,
- it does not depend on distance through regime switching.

The luminal mode remains the same mode throughout propagation. The propagation speed remains invariant. The wave does not undergo phase transitions along its path.

Any attempt to explain redshift by invoking successive medium phases along the line of sight would reintroduce precisely the kind of dissipative or scattering processes that Quarkbase explicitly excludes.

5.4 Correct placement of tri-regime physics in the redshift problem

The correct role of tri-regime physics is **contextual, not causal**.

The tri-regime structure determines:

- how the global state of the Ψ-field evolves,
- how large-scale organization influences medium parameters,
- how the effective index $n(t)$ acquires its cosmic-time dependence.

Once that global evolution is fixed, the redshift follows directly from the comparison between emission and observation states, as described in Section 3.

In short:

- **tri-regime physics shapes the medium's evolution**,
- **the evolution of the medium fixes** $n(t)$,
- $n(t)$ **determines the redshift**.

The tri-regime structure is therefore part of the **background architecture** of the universe, not the immediate engine of spectral shifting.

5.5 Why this clarification matters

Failing to separate structural properties from causal mechanisms leads to unnecessary complications and conceptual errors. By clearly isolating the role of tri-regime behaviour, Quarkbase Cosmology avoids attributing the redshift to ad hoc transitions or propagation effects.

This separation preserves:

- the non-dissipative nature of the luminal mode,
- the achromatic character of cosmological redshift,
- and the coherence of the theory across scales.

The redshift remains a clean diagnostic of the Ψ-field's temporal evolution, while tri-regime physics remains responsible for the universe's large-scale organization.

6 Immediate consequences and falsifiable implications

6.1 Reinterpretation of the Hubble law

In standard cosmology, the empirical relation between redshift and distance is codified as the Hubble law and interpreted kinematically: greater redshift implies greater recessional velocity. In Quarkbase Cosmology, the same empirical regularity admits a different and more direct interpretation.

The observed linear relation at low redshift is not a velocity law. It is the first-order expansion of the temporal evolution of the propagation index $n(t)$ of the Ψ-field. At leading order, small differences between $n(t_{\text{emit}})$ and $n(t_{\text{obs}})$ produce a redshift proportional to lookback time, which correlates observationally with distance.

Thus, the Hubble law becomes:

- a phenomenological encoding of how $n(t)$ varies over recent cosmic history,
- not a statement about the motion of galaxies through space.

This reinterpretation preserves the observational success of the Hubble relation while removing the need to assign physical velocities to cosmological redshifts.

6.2 No need for accelerated expansion or dark energy

In standard cosmology, deviations from a simple linear redshift–distance relation—most notably those inferred from type Ia supernovae—are interpreted as evidence for accelerated expansion, leading to the introduction of dark energy as a dominant cosmic component.

In Quarkbase Cosmology, this inference is not required.

If the propagation index $n(t)$ evolves nonlinearly with cosmic time, then the observed redshift–distance relation will also exhibit nonlinear behaviour. Such deviations reflect changes in the physical state of the Ψ-field, not a change in the acceleration of space itself.

Consequently:

- there is no need to postulate a new energy component with exotic properties,
- there is no requirement for negative pressure or vacuum energy,
- the apparent acceleration arises naturally from medium evolution.

Dark energy, in this framework, is not a physical substance but a **misinterpretation of medium dynamics as geometry**.

6.3 Redshift as a probe of the Ψ-field evolution

The redshift becomes a direct observational probe of the large-scale evolution of the Ψ-field.

By reconstructing $n(t)$ from redshift data, one gains access to:

- the temporal relaxation or reconfiguration of the medium,
- the global structural evolution of the universe,
- and the coupling between large-scale organization and local physical processes.

This shifts the cosmological program from fitting geometric scale factors to **inferring physical medium properties**.

6.4 Falsifiable observational signatures

Quarkbase Cosmology makes concrete, testable predictions that distinguish it from purely geometric models.

1. **Consistency across observables**
   The same function $n(t)$ must simultaneously account for redshift, gravitational lensing, and time-delay phenomena. Any inconsistency between these probes would challenge the framework.

2. **Environmental sensitivity**
   Because $n(t)$ is a property of the medium, small systematic deviations in redshift may correlate with large-scale environments (e.g. dense supercluster regions versus cosmic voids). Such correlations are not expected in a purely metric interpretation.

3. **Reconstruction without dark energy**
   Supernova luminosity–distance relations should be reproducible using a physically plausible evolution of $n(t)$, without invoking an additional dark-energy term. Failure to do so would falsify the model.

4. **Unified interpretation of optical effects**
   Redshift, lensing, and other relativistic optical phenomena should admit a unified description in terms of Ψ-field variations. Disparate parameter requirements across phenomena would undermine the approach.

These predictions are not post hoc adjustments; they arise directly from the central redshift law and the physical role assigned to the Ψ-field.

6.5 Conceptual economy and explanatory gain

By reinterpreting redshift as a material effect, Quarkbase Cosmology achieves a reduction in ontological and theoretical complexity.

- No expanding space is required.
- No acceleration of the universe is postulated.

- No dark energy component is introduced.

Instead, a single evolving physical medium accounts for a broad range of observations. The redshift ceases to be an indirect geometric clue and becomes a direct physical diagnostic.

7 Conclusion

The cosmological redshift is one of the most fundamental observational facts in astronomy. In the standard framework, it is interpreted geometrically, as evidence that space itself expands and that distant galaxies recede accordingly. This interpretation, however, rests on an implicit postulate: in the absence of a physical medium, the observed frequency shift is attributed to a rescaling of the mathematical norm used to define distances and times.

Quarkbase Cosmology follows a different path. By restoring a physical substrate—the Ψ-field—it removes the need for geometric inflation and resolves the conceptual ambiguity inherent in the standard picture. Light is treated as a coherent, non-dissipative resonant mode of this medium, and frequency is recognised as a local, medium-coupled quantity rather than an intrinsic property carried unchanged through empty space.

Within this framework, the cosmological redshift emerges as a simple and physically transparent effect. It reflects the difference between the state of the Ψ-field at the time of emission and at the time of observation. The entire phenomenon is captured by a single operational law:

$$1 + z = \frac{n(t_{\text{obs}})}{n(t_{\text{emit}})}.$$

No expansion of space, no global kinematics, and no accelerated dynamics are required. The observed increase of redshift with distance is not a sign of objects moving ever faster away, but a consequence of observing earlier epochs in which the physical state of the medium was different.

The tri-regime structure of the Ψ-field provides the large-scale architectural context for this evolution, but it is not the direct cause of spectral shifting. Redshift remains a clean diagnostic of the temporal evolution of the medium, while structural regimes govern stability and organization across cosmic scales.

By reinterpreting redshift as a material phenomenon, Quarkbase Cosmology preserves the empirical successes of standard cosmology while eliminating the need for speculative entities such as dark energy. More importantly, it transforms the redshift from a geometric proxy into a direct probe of the universe's physical substrate.

In this sense, cosmological redshift ceases to be an abstract consequence of expanding coordinates and becomes what it should always have been: a measurable imprint of the evolving physical state of the universe itself.

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