EXPANSION-DEFINED RELATIVITY (EDR)

A conceptual framework by David Suttle

Abstract

Expansion-Defined Relativity (EDR) proposes that the physical rate of time is determined by the local rate of spatial expansion, and that mass suppresses this expansion. In this framework, expansion is not a movement through the universe, but an intrinsic attribute of its fabric that drives the fundamental oscillations of matter and energy. Mass depresses expansion, and gravity emerges as motion along gradients of reduced expansion. This model yields a unified interpretation of cosmology and quantum time while resolving the H_0 (Dark Energy) as a perspective artifact. EDR is constructed to reproduce all classical tests of General Relativity (GR) in the weak-field limit.

1. Introduction

General Relativity (GR) describes gravity as the curvature of spacetime. While highly successful, it requires dark matter and dark energy to explain large-scale observations, and it leaves a conceptual gap with quantum mechanics - particularly regarding the nature of time.

Expansion-Defined Relativity (EDR) bridges these gaps by starting from a single physical principle: Expansion of space drives the existence and flow of time.

- Expansion is an intrinsic property of space.
- Expansion and time are inseparable; they are the same physical process.
- Expansion generates time - it does not occur within time.
- The passage of time is the local rate at which space expands.
- Mass suppresses expansion, slowing the local rate of time.
- Gravity is motion along gradients in suppressed expansion (and hence suppressed time).

Because the local rate of time is directly tied to the local expansion field, EDR provides a unified picture of gravitational time dilation, black-hole horizons, and cosmic acceleration.

2. Core Postulates of EDR

2.1 Expansion as the "heart-beat" of Time

Expansion is a fundamental background property of the fabric of space. In EDR, the rate of expansion is represented by the scalar field (ϕ), which dictates the rate of all physical processes, from motion to light frequencies to quantum phase evolution. The local proper-time rate ($d\tau$) is the literal manifestation of the expansion of space.

- **Fast Time (High ϕ):** faster oscillations.
- **Slow Time (Low ϕ):** slower oscillations.
- **Expansion approaches zero:** all physical processes cease; $\phi \to 0$ implies $d\tau \to 0$

2.2 Mass-energy as a Sink for Expansion

Mass-energy density (ρ) reduces the local expansion field. Mass-energy acts as a sink, inhibiting the fabric's intrinsic ability to expand and drive physical change.

- High density → strong suppression → slow time
- Low density → weak suppression → fast time

2.3 The Immutable Link: Double Suppression

Because the expansion field ϕ is the single substrate for both distance and duration, they are immutably joined. Any suppression of expansion by mass-energy must affect both dimensions simultaneously and proportionally. Regions with suppressed ϕ have both shorter distances and slower clocks.

2.4 Gravity as a Gradient of Suppression

Mass suppresses expansion most strongly near its centre, creating a spatial gradient in ϕ. Gravity is motion along this gradient; objects follow geodesic paths determined by how the expansion rate changes in space.

3. Physical Consequences

3.1 Refractive Gravity and Light Bending

Mass-energy suppresses both the rate of time and the scale of space. This "double suppression" acts like a refractive index, matching Eddington's light-bending tests (1.75 arcseconds). In EDR, this is simply the consequence of light passing through a region where the expansion "heart-beat" has been dampened by mass.

3.2 Black Holes as Gradient Horizons

In EDR, a black hole is not a singular boundary but a region where the expansion field ϕ becomes extremely small. As mass-density increases, ϕ is progressively suppressed, and the rate of time slows accordingly. The "event horizon" is therefore not a sharp surface but the region where the gradient of suppressed expansion becomes extremely steep.

This gradient-based horizon removes the strict one-way nature of black holes in GR. Outward motion is not forbidden; it is simply governed by a region of extremely slow time. Escape is possible in principle, but would require an external duration so long that it is observationally irrelevant. The horizon behaves like a practical barrier, not an absolute one.

Because time never reaches zero in finite proper time, no true singularity forms. Collapse simply slows as ϕ decreases, producing a "frozen" interior rather than an infinite-density point.

3.3 Voids and the Illusion of Dark Energy

In low-density cosmic voids, expansion is unsuppressed and time runs faster. Using "slow" clocks inside galaxies to measure "fast" void expansion creates the appearance of acceleration - the effect attributed to dark energy.

3.4 The illusion of Dark Matter

In EDR, the structure of the expansion field manifests naturally as effects attributed to dark matter. At the edges of galaxies, stars sit closer to surrounding cosmic voids where ϕ is higher and time runs faster. This creates an outward gradient in the expansion field that boosts orbital velocities without requiring additional unseen mass-energy. The apparent need for dark matter is therefore an artefact of comparing regions with different expansion-driven time rates, not evidence of a missing mass component.

3.5 Early Universe

When the universe's mass was concentrated in a small volume, expansion was maximally suppressed everywhere. From inside the universe, this appears as a sudden beginning (Big Bang) and rapid inflation. From an external perspective, the universe could have evolved extremely slowly over an arbitrarily long duration.

This in turn means there is no need for a new "Inflation field" to explain the big bang.

The universe only has an appearance of a "beginning" when viewed from the inside; from the perspective of a hypothetical viewer outside the universe, no such beginning is necessary.

3.6 Quantum Time

Quantum phase evolution depends on proper time. If proper time is defined by expansion, then quantum frequencies, decay rates, and oscillations are governed by the same field that governs gravity and cosmology.

3.7 The Arrow of Time

Because the expansion field ϕ defines the local rate of time, its global behaviour sets the direction of time itself. Expansion is intrinsically monotonic: ϕ increases and is never reversed. Mass-energy can locally suppress ϕ, slowing time, but there is no mechanism to drive ϕ backwards. The arrow of time therefore arises directly from the universe's expansion.

4. Mathematical Structure

4.1 The Unitary Metric

Time and space are tethered to the same expansion-sink mechanism. The metric is expressed as:

$$ds^2 = -F(\phi)^2 c^2 dt^2 + F(\phi)^2 (dr^2 + r^2 d\Omega^2)$$

This ensures correct light-bending and Shapiro delay by scaling both clocks and yardsticks through the same field.

4.3 The Sink Equation

$$\nabla^2 \phi = \alpha \rho$$

Mass acts as a sink for ϕ, creating a gradient that recovers the inverse-square law of gravity. ϕ approaches a constant background value in low-density voids, providing the boundary condition for the sink equation. In the weak-field limit, small perturbations in ϕ reproduce the Newtonian potential and the inverse-square law.

4.4 GR Recovery Condition

$F(\phi)$ is a monotonic function of ϕ, ensuring that suppressed expansion corresponds to slower time and reduced spatial scale. EDR is constructed to reproduce all classical tests of GR in the weak-field limit. This requires:

$$F\big(\phi(r)\big)^2 \approx 1 + \frac{2\phi(r)}{c^2}$$

ensuring consistency with:

- Mercury's perihelion shift
- gravitational redshift
- light bending
- Shapiro delay
- GPS-level time dilation

5. Falsifiable Predictions

Clocks in deep cosmic voids should tick measurably faster than clocks in galaxies, beyond standard gravitational time dilation. This should be detectable in precision cosmological timing and redshift-drift measurements.

6. Plain-English Summary

There is one field, ϕ, representing the expansion rate at every point in space. Expansion and time are immutably joined; expansion is the fundamental "pulse" that drives the vibration and motion of all matter and light.

- Empty Space: expansion is unhindered; time runs fast.
- Near Mass-energy: mass-energy "soaks up" expansion.
- Result: less expansion → slower physical vibrations and motion → reduced local spatial scale.

Objects fall toward mass because they follow the gradient into regions where the fabric of the universe is less expanded. Phenomena like the "Big Bang", "Dark Energy", and "Dark Matter" are perspective illusions caused by measuring the universe with clocks slowed by the mass of our own galaxy.

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Collaboration Invitation

This paper sets out the core idea behind Expansion-Defined Relativity (EDR): that the rate of time is the rate of expansion, and that mass-energy slows both. The aim here isn't to present a finished theory, but to lay out a clear conceptual foundation that ties together gravity, time, cosmology, and several long-standing anomalies in a single, coherent way.

The next stage is to turn this framework into a full mathematical structure. That will need people with the right background in GR, scalar-field theory, cosmology, or related areas who can see the potential in the underlying idea and want to help shape it into something formal and testable.

If the core principle resonates with you - or if you can see a way to push the maths further - I'd welcome a conversation.