# A Brief History of the Universe According to the Emergent Time Framework (ETF)

Andrew Conrad Russell

If you are an academic physicist or a cosmologist and happen to have landed on this page, you will hopefully come to recognise how the ETF challenges some of the foundational concepts within the mainstream ΛCDM model using existing physics.

Before stepping into the specific mechanics of the ETF and what it represents, let us first reassure you about a few important foundational principles. It is vital to make clear exactly where the ETF aligns with the mainstream consensus, and where it fundamentally diverges.

**Where the ETF aligns with mainstream cosmology:**

- Preserving General Relativity: The ETF does not challenge or attempt to replace General Relativity. Instead, it extends its reach and explanatory power.
- The Standard Model: The Standard Model of particle physics remains fully intact; however, the ETF provides a native mechanical explanation for existing anomalies, such as the lithium abundance problem.
- Quantum Mechanics (QM): The ETF does not challenge quantum mechanics. Rather, it leverages QM's quantum action cycles to build a bridge to General Relativity.
- The post-Higgs Timeline: Following the electroweak decoupling and the emergence of the Higgs field at roughly $10^{-12}$ seconds, the ETF aligns almost perfectly with the standard ΛCDM developmental timeline of the cosmos. However, the ETF natively predicts an expanding universe, early mature galaxies, and higher galaxy rotation velocities at higher redshifts without requiring dark matter.

**Where the ETF diverges from mainstream cosmology:**

- The Block Universe: The ETF challenges the block universe paradigm, recognizing it instead as a highly effective postulate upon which General Relativity's field equations were built. It replaces the block universe with the postulate that energy transformation and time are conjugate: quantum action cycles generate time, which then translates into geometry (space) through the fundamental relationship $dx = c.dt$. As we will demonstrate, this new postulate organically explains cosmic phenomena that the current block universe cannot without introducing a cosmological constant, dark energy, dark matter, and singularities at the centre of black holes.
- The Planck Power Limit: In this framework, Planck power ($c^5/G \approx 3.6 \times 10^{52}$ watts) is recognised as the linear summation of all quantum action cycles across the cosmos. This metric expansion engine is responsible for what mainstream cosmology attributes to the dark sector. The observed effects of dark matter and dark energy are thus unified as a single, underlying phenomenon. While Planck power is often treated as a numerical coincidence, we will demonstrate that it is, in fact, the fundamental expression of the cosmos's energy transformation process. Given the fixed mass-energy of the cosmos, Planck power sets the absolute upper bound on the rate at which energy can be transformed or exchanged, and the rate at which the cosmos can expand.
- Bridging the Time Dichotomy: The ETF recognises that GR and QM treat time differently. By addressing this dichotomy directly, the two domains can potentially be bridged.
- Time as a Field: The ETF replaces the block universe's concept of time as a static dimension with time as a dynamic field overlaying the spatial x, y, and z dimensions. The proper time rate at any point is directly linked to the power flux at that point; the time field is therefore curved, or distorted, by the rate of localised energy transformation.

- Universal Energy Conservation: In General Relativity, global energy conservation is not enforced due to the metric expansion of space which breaks Noether's time translation symmetry. However, the ETF dictates that because energy conservation at the quantum level is absolute, summing these overlapping regions of quantum action cycles across the cosmos enforces strict energy conservation within all causal horizons, and thus ultimately, cosmic-wide.
- The ETF honours the original, unmodified equations of General Relativity by removing the need for an ad hoc cosmological constant; the metric expansion attributed to dark energy is instead driven by cosmic wide quantum action cycles which sum up to Planck power.

The ideas summarised above are covered in pre-print papers, which will be linked to in this article, allowing readers to explore the concepts in more depth should they wish to.

Although the philosophical idea of 'emergent time' has existed within academia for at least two or three decades, the ETF is the first attempt to rethink the mechanics from the ground up, applying it as a comprehensive, falsifiable theory with the potential to seriously challenge the ΛCDM paradigm.

## 1. Rethinking the Pre-Electroweak Decoupling Epoch

Very little is known about the universe prior to the electroweak decoupling at around $\sim 10^{-12}$ seconds. Before this, in the very early stages of the primordial cosmos, it is thought that at timescales below $10^{-36}$ seconds, the universe was composed solely of radiation and was incredibly energetic ($\approx 10^{15}$ GeV), existing in a very dense, near-singularity state. At $10^{-36}$ seconds, an inflaton nucleated in this domain, accompanied by an associated inflaton field, which caused the cosmos to rapidly expand until $10^{-34}$ seconds. At $10^{-34}$ seconds, the inflaton and its associated field switched off, with the previous energetic state diluted substantially. It is sometime between the end of inflation and the electroweak decoupling at $10^{-12}$ seconds that matter and anti-matter annihilate and baryogenesis takes place, leaving just photons and matter, which at this point does not have the property of mass. The universe continues to expand, albeit at a much slower rate, until at $10^{-12}$ seconds, it crosses the 159 GeV threshold, at which point the Higgs field emerges and all matter instantly acquires mass. Other than the theoretical work of Alan Guth and Andrei Linde on inflation, we have no hard physical evidence for an inflaton and its associated field. We do not possess the technology to create the necessary energy densities with which to observe the nucleation of such a particle or its field. We can point to the inflationary epoch as providing an explanation for the exceptional homogeneity of the CMB and a resolution to the monopole problem, but as we will propose later, there are more prosaic explanations resting on existing physics that do not require the exotic inflaton.

In the ETF, it is proposed that energy transformation and time are linked as a conjugate pair, in a fashion somewhat similar to the way space and time are one and inseparable in Minkowski's spacetime metric. Given that photons, which are massless, travel along null geodesics ($ds = 0$), in the ETF it is only mass-bearing matter that can experience time, best captured by Heisenberg's uncertainty principle $\Delta E \Delta t \geq \frac{\hbar}{2}$. Just as the block universe is a foundational postulate in General Relativity, in the ETF, the foundational postulate is that time is nucleated from quantum action cycles such that $t_0 = \frac{\hbar}{\Delta E_{\text{internal}}}$ and therefore $t_0 = \frac{\hbar}{m_0 c^2}$. In this view, time cannot exist without mass, but more importantly, quantized packets of time ($t_0$) are generated by quantum action cycles within matter. With this view in mind, we propose an alternative timeline hypothesis for the cosmos from the GUT epoch up until just beyond the electroweak decoupling.

Prior to the electroweak decoupling, the universe exists in a highly energetic, near-singularity state. There is no mechanism that allows it to move from the estimated $\approx 10^{15}$ GeV energy densities down towards the 159 GeV threshold to allow the Higgs field to nucleate. The only known theoretical particle that possesses mass without the Higgs field is the super-heavy, right-handed Majorana neutrino, which is very rare and very unstable. The hypothesis, therefore, is that within this primordial 'soup', super-heavy Majorana neutrinos exist in quantum state fluctuations, and with each quantum action cycle, a packet of time is nucleated. Since $dx = cdt$, this process acted as a metric pump, slowly diluting the energy density until it eventually crossed the 159 GeV threshold. The ETF proposes this 'slow leak' era provides the exact non-equilibrium environment required for these highly unstable

Majorana neutrinos to decay, naturally driving Leptogenesis and elegantly resolving the matter-antimatter asymmetry (Baryogenesis) right before the Higgs mechanism fires. It is important here to note that inside the cosmos during that epoch, all matter was moving along null geodesics at the speed of light, so effectively no time passed, other than the diluted ‘tick’ from the Majorana neutrinos' quantum action cycles. From an outside observer’s perspective, this suspended state could have been maintained for millions of years—we won’t have a firm idea on the exact temporal scales (as outside observers) until more work is done on the exact prevalence of these particles during that epoch. Inside the cosmos during this epoch, time and therefore geometry for the vast majority of the particles post-baryogenesis had no meaning, and it is therefore best characterised as an a-temporal, a-geometric domain.

As the energy level within this domain crossed the critical 159 GeV energy threshold, the electroweak interaction separated into two distinct forces: the electromagnetic interaction and the weak interaction. Simultaneously, the Higgs field emerged, and fundamental particles—including the W and Z gauge bosons—abruptly became massive, while the photon remained massless and continued as a long-distance interaction. From $t_0 = \frac{\hbar}{m_0 c^2}$, and thus from $dx = cdt$, this simultaneous mass acquisition ignited geometry. In the ETF paradigm, the mainstream inflationary epoch between $10^{-36}$ and $10^{-34}$ seconds is moved and takes place around $10^{-12}$ seconds. Since energy is conserved in quantum action cycles, time, and hence geometry, must sum linearly, yielding an enormous superluminal spike in the volume of the cosmos.

This Higgs-driven inflationary epoch sees the energy level almost instantaneously collapse. Following this geometric spike, between $10^{-12}$ and $10^{-5}$ seconds, the universe was filled with a hot quark-gluon plasma, handing the baton back to directly accessible particle physics. As the temperature continued to fall to roughly 150 MeV at around $10^{-5}$ seconds, chiral symmetry breaking occurred. At this point, the quark-gluon plasma coalesced into hadrons, consisting mostly of protons, neutrons, and pions. Beyond this, the ETF cosmic timeline remains aligned with the mainstream standard model, but because we have invoked the idea that time is actively nucleated out of quantum action cycles rather than being a pre-existing container, the framework provides mechanical answers to observables that standard cosmology cannot.

Although the development of the pre-electroweak decoupled cosmos described above relies on a theoretical particle—the super-heavy Majorana neutrino—it is a much easier timeline to explain than current inflationary models. The latter requires that the particle and its associated field turn on and turn off at precisely $10^{-36}$ and $10^{-34}$ seconds respectively, whereas no such critical timing in the ETF model is required. Further, one of the problems standard models grapple with is the abundance of magnetic monopoles in the primordial universe. Despite extensive research, magnetic monopoles do not seem to exist in the cosmos today, and these were, it is assumed, diluted out of the cosmos during the inflationary epoch. The ETF timeline does not suffer from a monopole problem because the cosmos before $10^{-12}$ seconds is a-temporal and a-geometric, so no spatially defined structures can exist in such an environment. Furthermore, even if primitive topological defects somehow formed during the slow volume leak, the explosive superluminal spatial spike at 159 GeV would have instantly diluted them away.

Finally, one of the challenges cosmologists faced prior to Alan Guth’s inflation theory was how to mitigate the extreme precision with which the early universe must have had to grow in order not to collapse, or to expand so rapidly that no large-scale structures could ever subsequently form. The required expansion rate precision to produce the universe we currently inhabit is 1 part in $10^{62}$. Inflation fixed this problem, but itself demands absolute precision in the timing of when the inflaton field activates and when it switches off. The ETF does not require any of these extreme precisions because time, and thus geometry, is nucleated from quantum action cycles. We will later also show this approach can natively explain the exquisite smoothness of the CMB without requiring an inflationary epoch.

## 2. Big Bang Nucleosynthesis (BBN)

As the cosmos expands and cools through 1 second and beyond, it passes through the standard gates consisting of neutrino decoupling, electron-positron annihilation, and then into the BBN epoch, which yields hydrogen, helium, and a small amount of lithium. In the standard timeline, all of the energy in the cosmos is assigned to the thermal photon bath because the cosmos is treated as a pre-existing container that expands without any energy requirement, i.e., for free. In the ETF, however, macroscopic space is not free; it is the active exhaust of the total quantum action cycle processing that sums up to the Planck power ($c^5/G$).

Rather than a passive split, the universe acts as a thermodynamic engine. As we demonstrated in 'A Thermal and Kinematic History of the Cosmos Derived from the Planck Power Hamiltonian,' 70% of the processed Planck power is expended to perform the mechanical work of metric expansion—the nucleation of time and geometry. This leaves only 30% of the energy retained as the thermo-kinematic heat of the plasma. Because the ETF universe is adiabatic and energy is conserved, it must 'pay' for the expanding manifold, so it operates on a significantly reduced thermal budget compared to standard models.

Because Standard Model nuclear cross-sections and weak interaction rates are functions of absolute local thermal energy, a given nuclear freeze-out gate occurs at fixed thermodynamic temperature milestones. While this 30% thermal retention does not affect the inventory levels of precursor elements with high thermal headroom (like $^4$He and $^7$Be), it drastically impacts the extended synthesis window of $^7$Li. In the standard model, this window extends to roughly 4400[1] seconds. In the ETF, the reduced thermal budget exhausts this window 50% earlier, truncating it at about 2200 seconds. In this timeline, the Standard Model elemental inventories all remain intact except for $^7$Li, which is natively reduced by around 50%. This elegantly resolves the lithium abundance anomaly entirely from within existing physics, removing the need for later ad hoc stellar depletion models or fine-tuning.

## 3. The z > 1100 universe, the BAO and the CMB

Following the explosive geometry spike of the Higgs transition, the universe operated as a hyper-dense, adiabatic photon-baryon fluid up until Recombination at roughly $z = 1100$. In standard cosmology, Baryon Acoustic Oscillations (BAOs) are viewed as spherical sound waves sloshing inside a passive, pre-existing spatial bucket, driven by the competing forces of gravity attempting to collapse the structure and photon radiation pressure forcing expansion. However, in the ETF, this fluid's energetic transformations are actively generating the spatial bucket itself. If a localized region of the primordial plasma became too dense, the temporal generation engine approached saturation, stalling local proper time emergence. To resolve this structural phase conflict, the system was forced into a violent kinematic response—an acoustic shockwave that rapidly expanded the local spatial volume, immediately dropping the density and restoring the temporal baseline. This localized energy-to-geometry regulation acted as an enormous hydrodynamic stirrer, actively ironing out tiny anisotropies via Silk Damping and driving the universe toward extreme smoothness.

When the universe cooled enough for electrons to bind to protons ($z = 1100$), the fluid became transparent, photon pressure vanished, and this hydrostatic feedback mechanism rapidly switched off. The BAO signature we observe today is the fossilized, frozen record of this dynamic spatial-regulation engine finally relaxing. In standard cosmology, the maximum distance these acoustic waves could travel before Recombination is known as the sound horizon, which astronomers use as a standard cosmological ruler. However, standard models calculate the size of this ruler assuming a passive, easily stretched metric. Under the ETF, the early universe possessed a highly elevated metric stiffness, or acceleration floor. Because the acoustic shockwaves had to perform significantly more mechanical work to push against this stiff spatial metric to generate volume, their propagation was constrained. Consequently, as detailed in "The Emergent Time Framework: Resolving the Dark Sector and Hubble Tension Through Planck Power", the ETF dictates that the true BAO sound horizon is contracted by approximately 4% compared to the standard model's passive-vacuum prediction.

This 4% contraction is a critical feature of the framework because it directly addresses one of modern cosmology's most glaring crises: the Hubble tension. Observational cosmologists use the frozen BAO sound horizon to infer

[1] In this article we take the BBN window to the full 4400 seconds to account for all of the elemental synthesis abundances and trace elements. Most text truncate the synthesis window at ~1000 seconds, which accounts for about 99.9% of the primordial elemental inventory levels.

the early universe's expansion rate (the Hubble constant) from Cosmic Microwave Background data. Because standard models overestimate the physical size of the standard BAO ruler, the expansion rate is inherently underestimated, yielding artificially low early-universe Hubble values, such as the Planck Collaboration's roughly 67.4 km/s/Mpc. By applying the ETF's metric stiffness and correcting for the 4% contracted sound horizon, the math realigns. The early-universe Hubble value shifts naturally upward, resolving perfectly to the unperturbed mid-redshift consensus value of approximately 70.04 km/s/Mpc (NASA NED dataset).

## 4. The Nature of the Early Cosmos - Introducing the Acceleration Floor and Metric Stiffness

After the $^7$Li production window closes, the cosmos continues to expand rapidly. While the milestones of mainstream ΛCDM cosmology, such as the mature, early galaxies imaged by JWST, align chronologically with the ETF narrative, the underlying nature of the metric is fundamentally different.

The standard model sees the cosmos as a container, predicated on the idea of a block universe in which the 'now' is simply an instant on a pre-existing continuum. In the ETF, however, time—and therefore space—is actively nucleated by quantum action cycles, and the cosmos is treated as a closed, conservative adiabatic system. Because the cosmos is actively expanding, it must confer a minimum acceleration threshold upon the metric that any matter must overcome to be spatially displaced.

The idea of a baseline acceleration floor does not exist in the ΛCDM paradigm because of the way it views the vacuum, but in the ETF, we define this global acceleration rate mathematically as

$$a_{\text{global}} = \frac{c^4/G}{c^3/\big(2GH(z)\big)} = 2cH(z)$$

This is the fundamental, unpartitioned acceleration floor, and it is directly linked to the prevailing epochal Hubble parameter, $H(z)$. We then partition this raw value to account for the spatial degrees of freedom. For a 3D isotropic space, the floor ($a_F$) is

$$a_F(z) = 2cH(z)\left(\frac{1}{24\pi}\right) = \frac{cH(z)}{12\pi}$$

For a 2D anisotropic space, such as matter organizing into a galactic disk, the floor ($a_0$) becomes

$$a_0(z) = 2cH(z)\left(\frac{1}{12}\right) = \frac{cH(z)}{6}$$

These acceleration floors endow the metric with a property we term 'metric stiffness', denoted by $S_T$, within the framework. Because metric stiffness scales linearly with the Hubble parameter, the early universe possessed a profoundly stiffer metric than the current, late-universe epoch. Using the unperturbed, empirical late-universe Hubble constant ($H_0 \approx 70.04$ km/s/Mpc), the present-day value for the 3D isotropic floor is $a_F \approx 1.8 \times 10^{-11}$ m/s$^2$. The 2D anisotropic floor resolves to $a_0 \approx 1.13 \times 10^{-10}$ m/s$^2$.

This late-universe value for $a_0$ is remarkably congruent with Milgrom's empirical MOND constant of $1.2 \times 10^{-10}$ m/s$^2$. However, unlike MOND, this floor acceleration rate is not an ad hoc insertion; it is derived entirely from first principles using a single empirical anchor, $H_0$.

The Emergent Time Framework (ETF) utilizes these first-principles derivations to resolve the galaxy rotation anomaly without the requirement for dark matter halos. The expanding metric natively enforces a baseline acceleration threshold ($a_0$) upon any matter organizing into a 2D anisotropic disk. This foundational requirement organically reproduces the Radial Acceleration Relation (RAR), providing an underlying mechanical reason why the empirically measured MOND acceleration constant sits precisely where it does in the local universe. Our work in "A Non-Dark Matter, Zero Free Parameter Solution to the Galaxy Radial Acceleration Relation" details the equations of motion through the derivation of the associated Lagrangian and Hamiltonian.

## 5. Escaping the ΛCDM Dark Ages

In the conventional ΛCDM paradigm, the epoch between recombination ($z \approx 1100$) and the first major eras of star formation is a prolonged dark age. During this time, baryonic gas must passively wait for invisible cold dark matter to slowly aggregate into gravitational wells. This sluggish, hierarchical assembly process is currently struggling to account for the mature, massive galaxies recently observed by JWST at $z > 10$.

However, in the ETF, the universe did not have to wait for dark matter to gather. The early cosmos possessed a heavily elevated metric stiffness ($a_F$), which acted as a violent, primary catalyst for structural nucleation, drastically accelerating the star and galaxy formation timeline.

At extreme redshifts ($z \sim 10$ to $15 +$), roughly 300 to 400 million years after the Big Bang, the background matter density was $10^3$ to $10^4$ times higher than today, accompanied by a ferocious early expansion rate. Because the ETF links the acceleration floor directly to the Hubble parameter ($a_F \propto H$), this high-redshift regime possessed an incredibly "stiff" spatial metric.

In this compressed environment, localized quantum action processing approached the Planck power saturation limit. As primordial gas reached critical density, local free-fall collapse times plummeted to 10 to 30 million years. Rather than slowly merging, the intense metric stiffness forced these primordial gas clouds to undergo a rapid topological phase transition—collapsing violently from a 3D volumetric blob-like state into a 2D surface-locked manifold (i.e., the galactic disk).

Because the early $a_F$ floor was orders of magnitude higher than today (e.g., at $z = 47$, roughly 30 million years post-Big Bang, the acceleration floor was $\approx 320$ times higher than today's local universe value), the energy threshold for this 3D → 2D transition was reached almost immediately.

This means the impossible early structures identified by JWST, such as the high-redshift proto-galactic blobs that eventually spin out into mature, massive disks like CEERS-2112 and ZF-UDS-7329, are not anomalies. They are systems that rapidly "snapped" into structural maturity due to the high-pressure, high-stiffness environment of the early metric. They represent the temporal saturation of the early manifold, where the rapid rate of time-creation allowed for galaxy assembly in a fraction of the time predicted by passive-vacuum models.

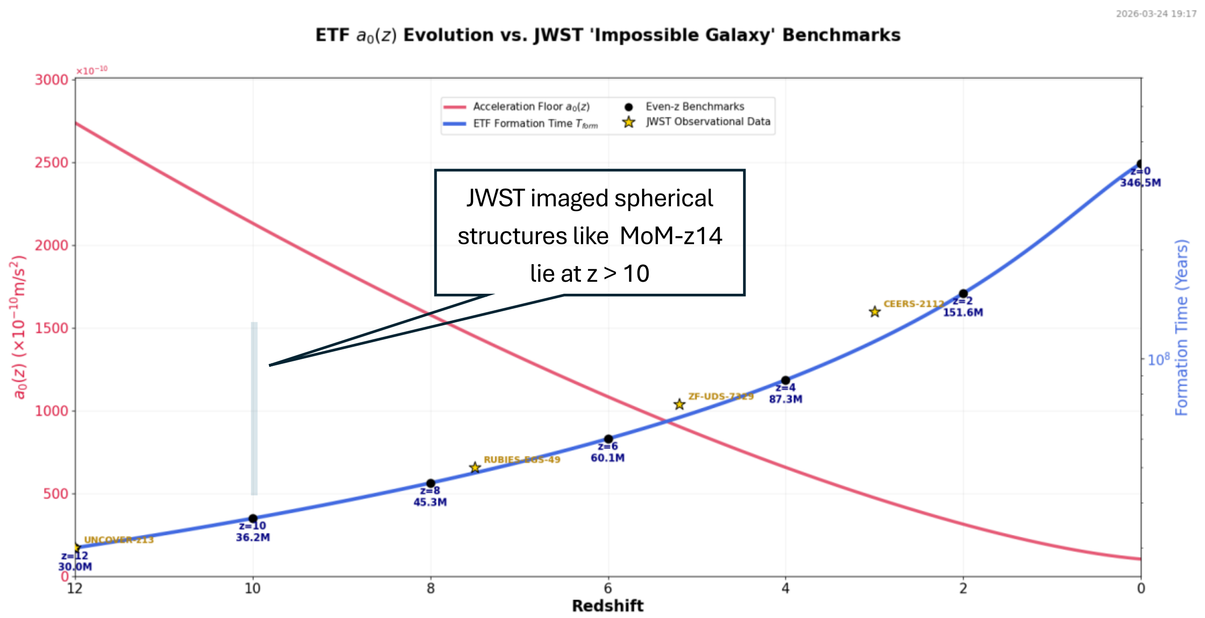


*Figure 1: Evolution of $a_0(z)$ and indicative galaxy formation time. The crimson line plots the $a_0$ acceleration floor (LHS y-axis) from the cosmic dawn, and the blue line plots the minimum formation time $T_{form}$ (RHS y-axis) for a Milky Way-class object. Markers on the $T_{form}$ curve (navy) denote even-redshift benchmarks, while the gold stars represent actual JWST early mature galaxy observations. At $z = 12$, the acceleration floor was $\approx 25$ times*

*higher than today, dynamically compressing the formation timescale to roughly 10% of what standard models require. The blue line represents the $T_{form}$ limit dictated by Planck power saturation; it defines the maximum metabolic speed at which gravity can organize matter into a 2D disk against the stiff $a_F$ background. All valid high-redshift galaxy observations must lie above this boundary—any fully formed disk falling below the blue line would constitute a direct falsification of the ETF.*

## 6. The DCBH Paradox and Early Reionization

The paradox of Direct Collapse Black Holes (DCBH), where massive black holes appear too early to have formed via standard stellar death, is similarly mitigated by this metric stiffness. The elevated $a_F$ environment acts as a structural shock absorber, dampening the chaotic over-fragmentation of gas clouds. This stability allows for a sustained, coherent collapse of extremely large gas volumes directly into supermassive black holes.

Consequently, in the ETF model, galaxy assembly and cosmic reionization occur in tandem. As these 2D manifolds nucleated at the elevated acceleration threshold, their massive, rapidly formed central stars and black holes immediately began pumping UV photons into the intergalactic medium, clearing the neutral hydrogen fog hundreds of millions of years earlier than ΛCDM allows. This head start neatly reconciles the mature structures we observe with the idea that the cosmic timeline is too short.

## 7. Galaxy Rotation Velocity Versus Redshift

One of the most important, testable implications of the ETF is that the rotation velocities of early galaxies must be significantly higher than those of similar mass in the late universe. Because the early cosmos had a much higher metric stiffness, all galaxies—from tiny dwarfs to massive spirals—were forced to rotate proportionally faster. The velocity multiplier at a specific redshift is the same, no matter what the galaxy mass, and is entirely dependent upon the $a_0$ acceleration floor value.

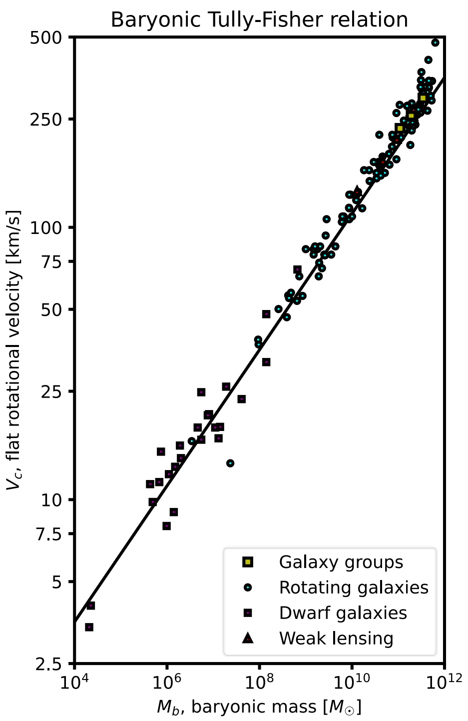


*Figure 2: Baryonic Tully-Fisher Relation (BTFR) showing how the asymptotic rotation velocity (y-axis) is closely bound to the baryonic mass of a galaxy (x-axis). The $a_0$ acceleration floor that underpins this relationship is taken in mainstream cosmology as an empirical observation, famously proposed as a required modification to Newton's laws of gravitation in the weak-field limit by Mordechai Milgrom in 1983. (Diagram adapted from Wikimedia Commons, CC BY 4.0).*

In mainstream cosmology, it is assumed that early universe galaxies would rotate at the same rate they rotate in the late universe, or perhaps even slower. In this paradigm, $a_0$ is taken as an empirical observation with no obvious theoretical underpinning, famously suggested by Mordechai Milgrom as a requirement for a modification to Newton's laws of gravitation in the weak-field. However, in the ETF, as we have shown in "Derivation of the 2D and 3D Cosmic Acceleration Floors from Invariant Planck Power", the 2D anisotropic $a_0$ value linked through first principles to Planck power (as is its 3D isotropic counterpart, $a_F$), and scales with the Hubble constant with redshift. In the ETF paradigm, galaxies must spin faster in the early universe because $a_0$ was much higher than it is in the late universe, and given by

$$a_{0(z)} = 2cH_{(z)}\left(\frac{1}{12}\right) = \frac{cH_{(z)}}{6}$$

Given this relationship, we are therefore able to accurately predict the rotation velocity of early galaxies as depicted in Figure 3 below.

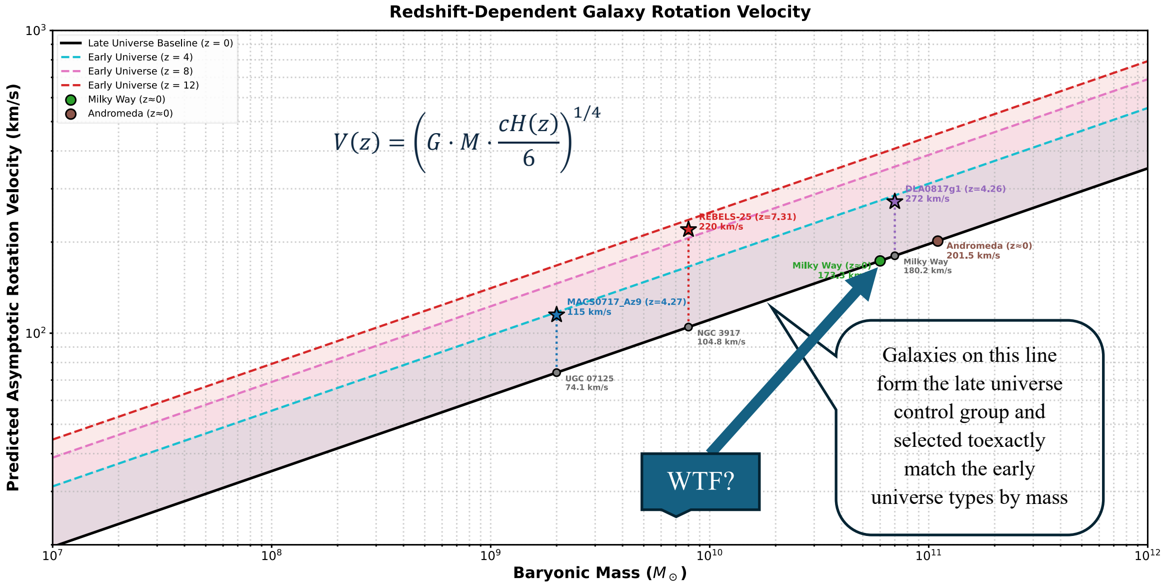


*Figure 3: This graph plots predicted galaxy rotation velocity versus redshift for a range of baryonic masses based upon the ETF expanded BTFR*

Figure 3 plots the predicted rotation velocity of early universe galaxies exactly matched to late universe counterparts by mass. Few comprehensive observations of early universe galaxies with accurate rotation data exist (as of August 2026) except for the 3 shown in Figure 3 – MACS0717_Az9, REBELS-25 and DLA0817g1. By matching these to late universe galaxies by exact mass, we can apply the ETF expanded BTFR to predict the rotation velocities and test those against the measured data

$$V(z) = \left(G \cdot M \cdot \frac{cH(z)}{6}\right)^{1/4}$$

Table 1 below details the results.

| Early Universe Galaxy | Redshift (z) | Baryonic Mass | Specific Local Counterpart | Local Control Late Universe Baseline (Vz=0) | ETF Early Universe Type Prediction (Vz) | Actual Observed Velocity (Vobs) |
|---|---|---|---|---|---|---|
| MACS0717_Az9 | 4.27 | $2.0\times10^{9} M_\odot$ | UGC 07125 | ≈74 km/s | ≈119 km/s | 115 km/s |
| DLA0817g1 (Wolfe Disk) | 4.26 | $7.0\times10^{10} M_\odot$ | Milky Way | ≈180 km/s | ≈290 km/s | 272 km/s |
| REBELS-25 | 7.31 | $8.0\times10^{9} M_\odot$ | NGC 3917 | ≈105 km/s | ≈200 km/s | 220 km/s |

*Table 1: Early universe galaxies are matched to late universe galaxies by exact mass. The expanded BTFR accurately predicts the rotation velocity of the primordial galaxies as indicated in the last two columns. The calculated values in this table do not take into account the macroscopic environment the galaxies may be embedded in.*

Given the difficulty in extracting accurate rotation curves for early universe galaxies, the relatively minor 10% deviation observed at $z = 7.31$ (look-back time > 11 billion years) for REBELS-25 underscores the robust predictive success of the ETF expanded BTFR relationship.

As detailed in “Derivation of the 2D and 3D Cosmic Acceleration Floors from Invariant Planck Power”, it is important to note that if a galaxy is being imaged within a cluster or other large mass bearing structure, it will elevate the $H_{(z)}$ value for the galaxy, and this must be accounted for when calculating rotation velocities.

As more early universe galaxy rotation data becomes available from platforms like the JWST and ALMA, it will show that the rotation velocity of these objects will closely follow the expanded BTFR relationship detailed above.

To verify that the galaxy rotation curves follow this relationship, place the early universe galaxy on the appropriate redshift plot line and x-axis mass. A late universe galaxy of the exact same mass must be paired with its early universe counterpart. There will be a vertical line connecting the two objects on the plot. Any galaxy pairing not following this rule will invalidate the claim that rotation velocity scales with not only baryonic mass, but also redshift.

While the Milky Way offers the most accessible kinematic data, utilizing our host galaxy as a primary theoretical anchor presents significant observational challenges. The astronomical community universally acknowledges that determining the Milky Way's exact baryonic mass is fraught with uncertainty because observations must be made from within the system, looking through the disk's dense dust lanes. Consequently, the accepted mass range for Milky Way-class spirals remains exceptionally broad, typically spanning from 10^10 to 10^11 solar masses.
Furthermore, the Milky Way is subject to local metric fluctuations. The gravitational compaction and peculiar velocities driven by the local supercluster environment introduce a measurable variance of approximately 2% to 5.6% from the global cosmic expansion baseline. While this local metric stiffness accounts for minor kinematic deviations, it represents only a ~5% contributor to the overall rotational profile. Therefore, the internal mass estimation errors prevent the Milky Way from serving as a rigid, unassailable baseline for comparative cosmological models.
To bypass the embedded observer problem, this analysis relies exclusively on external galaxies where the total baryonic mass profiles can be viewed unobstructed. While high-redshift mass extractions carry their own inherent uncertainties—such as instrumentation noise, beam-smearing effects, and mass-to-light ratio scaling variances—these can be effectively neutralized through population cross-section analysis. By pairing early-universe observations with external late-universe SPARC archetypes of identical mass brackets, the absolute mass variable is controlled, isolating the background metric stiffness as the primary independent kinematic driver.

## 8. The JWST Early Spherical Structures

In the standard ΛCDM model, cosmic structure formation is a hierarchical and gradual process. According to this traditional view, gravity slowly pulls matter together, meaning the earliest structures to form should be relatively small Population III stars and dwarf galaxies, which then take hundreds of millions of years to merge into larger, organized systems.

However, recent observations from the James Webb Space Telescope (JWST) have severely challenged this timeline. JWST has peered deep into the cosmic dawn, revealing unexpectedly massive, luminous, and compact blob-like spherical structures—including the remote galaxy MoM-z14 at redshift $z = 14.44$ ($> 12$ billion years look-back time) along with an unexpected abundance of giant black holes. The surprisingly fast gas cloud condensation and stellar birth rates required to build these objects simply do not fit comfortably within the slow, step-by-step stochastic assembly models predicted by mainstream ΛCDM cosmology.

Within our framework, these ultra-early, amorphous spherical structures are exactly what we should expect to see. Rather than pointing to a flaw in our understanding of galaxy formation, they perfectly illustrate how matter behaves in an early universe characterized by high metric stiffness and high background matter densities.

At extreme redshifts ($z > 10$), the background acceleration floor is $> 300$ times higher than it is in the present epoch. In this stiff metric environment, localized gravitational collapse was violent, fast, and predominantly radial. Matter and gas plunged inward so rapidly that the standard mechanisms of angular momentum transport did not have time to spin the system up. Instead of settling into a flattened, rotating disk, the proto-galaxies virialized through random, chaotic dispersion. This rapid radial assembly produced exactly the compact, dispersion-dominated spheroids that JWST is currently imaging at these extreme redshifts.

These structures were not the final state of these galaxies, but rather their high-density seeds. As the universe expanded and the background metric stiffness relaxed, the intense inward radial pull softened. This allowed the system's gravitational sphere of influence—the metric coupling radius $r_{MC}$, which we introduced in "A Non-Dark Matter, Zero Free Parameter Solution to the Galaxy Radial Acceleration Relation" —to gradually migrate outward. As this boundary expanded, fresh baryonic gas from the surrounding cosmic web began falling into the system. Because this later-infalling matter possessed naturally higher specific angular momentum, its accretion provided the rotational energy required to spin the system up. As this new gas collided, cooled, and dissipated its chaotic internal energy, conservation of angular momentum forced the system to settle into a flattened, rotating disk.

Within the framework presented here, the spherical structures imaged by JWST are the logical first step of galactic evolution in the early universe and a direct thermodynamic consequence of a stiff early metric that eventually yields to the majestic, rotating spiral disks we see in the later universe.

## 9. The Galactic Bars and Galaxy Assembly

For over four decades, mainstream ΛCDM cosmology has relied heavily on the existence of dark matter to explain both galaxy formation and structural dynamics. However, despite exhaustive, globally funded searches, the fundamental nature and production mechanism of this hypothetical particle remain entirely unknown. While standard models incorporate dark matter and dark energy into cosmological equations as effective mathematical placeholders, they fundamentally lack the foundational physics required to explain their origin. Given this reality, offering an alternative paradigm—one built upon empirical boundaries and known physics rather than undetected particles—is not just scientifically defensible; it is a necessary step forward.

The ETF provides this alternative. In *"*A Non-Dark Matter, Zero Free Parameter Solution to the Galaxy Radial Acceleration Relation", the flat rotation curve mechanics of the galaxy end-state were described. In that paper, the Lagrangians and Hamiltonians demonstrating precisely why mature spiral galaxies exhibit flat rotation curves without the need for dark matter halos were presented. While that work solidified the final structural state of galaxies, the detailed mathematical formalism of the evolutionary pathway—specifically the exact mechanics of the 3D-to-2D topological nucleation process—is the subject of active, ongoing investigation within the ETF paradigm. Nevertheless, there is much to be gained by offering an alternative galaxy assembly model that challenges the current idea that galaxies form through slow, chaotic accretion and merger processes, and instead explains this evolution natively, resolving the structural anomalies currently baffling the standard model.

Chief among these anomalies is the unexpectedly early emergence of distinct galactic bars recently observed by JWST and ALMA. In standard ΛCDM cosmology, galaxies are supposedly embedded within massive, spherical dark matter halos that act as giant gravitational cushions, stabilizing the baryonic disk and delaying the formation of central bars. The ETF eliminates the dark matter halo entirely, replacing it with the structural requirement of the $a_0$ metric acceleration floor. In the ETF, disks are completely baryon-dominated and exclusively self-gravitating, meaning they lack that spherical dark matter cushion. A rapidly rotating, self-gravitating disk without a massive halo is highly susceptible to global non-axisymmetric instabilities, specifically violating the Ostriker-Peebles criterion where $\frac{T}{W} > 0.15$ (with $T$ representing kinetic energy and $W$ total gravitational energy).

Within the ETF, it is hypothesized that this structural instability is catalyzed by a two-stage topological growth process dictated by the evolving cosmic environment. Initially, at extreme redshifts ($z > 10$), high metric stiffness forces proto-galaxies into dense, compact 3D spheres with sharply truncated gravitational horizons. As the universe expands and the global metric stiffness relaxes, this operational gravitational horizon sweeps outward, initiating a fierce second wave of accretion. The outward expansion of this boundary is governed by the metric coupling radius ($r_{MC}$), which represents a soft phase-change region in the spacetime manifold rather than a hard structural wall. The $r_{MC}$ is the equilibrium boundary between the accumulating baryonic mass and the prevailing background metric stiffness, establishing the absolute physical limit to which a galaxy can organically grow during a given cosmic epoch.

As the background metric softens and the galaxy nucleates into a 2D structure, the secondary influx of accreted matter arrives at velocities far exceeding the rotation rate of the dense central core. The proto-galaxy lacks the rotational velocity to smoothly distribute this rapid infall into an axisymmetric flat disk. Constrained externally by the $r_{MC}$ boundary and internally by a slowly rotating core, the kinetic pile-up of infalling matter has no avenue for dissipation. Consequently, as the z-axis contracts, the lack of a stabilizing dark matter halo forces the central region into the rotating bar observed in many spiral galaxies. This is the immediate, thermodynamically mandatory consequence of fast filamentary infall clashing with the $r_{MC}$ envelope as a halo-free disk matures out of the stiff early metric.

This mechanical pathway intrinsically explains the structural homogeneity of galaxies across the cosmos, a reality that standard cosmology struggles to justify. While ΛCDM galaxy assembly relies on the stochastic, highly randomized aggregation of dark matter halos and random galaxy mergers, observed galaxies fall neatly into just seven main structural types within the Hubble Sequence. This morphological limitation implies a constrained, deterministic assembly route rather than an ad-hoc merger history. We instead propose that the dominant assembly pathway for spiral galaxies is via topological nucleation, moving from an early 3D isotropic manifold compressed by the stiff $a_F$ acceleration floor down into a 2D anisotropic disk governed by the $a_0$ threshold. This transition is fully conservative. The enormous gravitational potential energy released during the contraction of the z-axis—

roughly $10^{51}$ joules for a Milky Way-scale object—is directly reassigned to the kinematic rotational energy of the disk. This directly generates the non-Newtonian rotation velocities required by the $a_0$ metric without any reliance on dark matter, locking most galaxies into a highly constrained topological assembly pathway.

## 10. Old Central Bulge, Young Spiral Arms

The hypotheses presented above natively explains the 'old bulge, young spiral arms' dichotomy observed by astronomers. In late-universe spiral galaxies, active star formation is almost exclusively confined to the outer disk and spiral arms, which are rich in cold molecular gas and HII regions. Conversely, classical central bulges are overwhelmingly "red and dead." They are dominated by older stellar populations, and their interstellar gas has typically been exhausted, violently heated, or blown out by early AGN activity, leaving them largely devoid of new star formation.

Astronomical surveys consistently show that spiral galaxies possess a pronounced negative radial metallicity gradient. The stars and gas in the central bulge and inner disk contain a significantly higher concentration of heavy elements than the stars forming in the outer spiral arms.

Within the ETF framework, this chemical gradient is a direct, mechanical consequence of the expanding metric coupling radius ($r_{MC}$)

- Stage 1 covers the central core enrichment phase. During the high-stiffness era, the massive, dense central sphere undergoes a fierce period of rapid star formation. Short-lived, massive stars quickly go supernova, seeding the dense local environment with heavy elements. Because the operational gravitational horizon is sharply truncated by the stiff metric, these heavy elements are tightly trapped, causing the core's metallicity to increase rapidly.

- Stage 2 covers the growth of the pristine disc. As the global metric relaxes and the $r_{MC}$ boundary migrates outwards, the galaxy begins drawing in fresh, relatively unenriched gas from the broader cosmic web. This pristine material fuels the formation of the 2D disk and the young spiral arms. Because this secondary gas influx is largely composed of primordial hydrogen and helium, the stars forming in the outer arms inherently possess a lower metallicity than the ancient, heavily enriched core. Furthermore, since the density of this infalling gas is lower, the overall rate of metal enrichment in the arms proceeds much more slowly than it did in Stage 1.

The ETF naturally weaves the chemical, chronological, and geometric properties of a galaxy into a single evolutionary timeline. It explains exactly why the core is older, spherical, and metal-rich, while the active outer disk is young, flat, and metal-poor.

## 11. Resolving the Late Universe Hubble Tension

To understand exactly how the ETF resolves the late-universe Hubble tension, we must look at the actual observational data. There is a well-documented discrepancy between the unperturbed expansion rate (with a consensus compromise often placed around 69.3 to 70 km/s/Mpc) and the localized expansion rate measured by the SH0ES team, which sits higher, at roughly 73.2 km/s/Mpc.

This creates a discrepancy range of approximately 3% to 4.2% between the global baseline and our local measurements. In standard cosmology, this gap is a crisis that threatens the standard model. In the ETF, this gap is the predictable, mechanical result of observing the universe from within a massive gravitational well.

Because our paradigm couples the global acceleration floor ($a_F$) to the Hubble parameter ($a_F \propto H$), an artificially elevated local acceleration floor mathematically forces a correspondingly higher local reading for the expansion rate. If we want to prove that the ETF is correct, the mass of our immediate cosmic neighborhood—the Local Supercluster (historically known as the Virgo Supercluster)—must be capable of elevating our local $a_F$ floor by exactly 3% to 4.2%. We will calculate this effect here and use the upper bound of the discrepancy to stress-test the math.

To force a baseline 70.04 km/s/Mpc reading (the unperturbed mid-redshift value from the NASA NED dataset) up to a localized 73.00 km/s/Mpc reading, the local acceleration floor must increase by exactly 4.22%. The baseline 3D isotropic acceleration floor (i.e., metric stiffness) $a_F$ is $1.806 \times 10^{-11}$ m/s$^2$. This would have to be raised by 4.22% in order to support the higher observed Hubble measurement, so the required additional contribution must be:

$$0.0422 \times (1.806 \times 10^{-11}) \approx 7.62 \times 10^{-13} \text{ m/s}^2$$

To resolve the Hubble tension, the Local Supercluster must exert a localized gravitational acceleration of exactly $7.62 \times 10^{-13}$ m/s$^2$ on our position.

We then use standard Newtonian gravitational mechanics to determine exactly how much mass is required to generate this acceleration vector from the centre of the Local Supercluster, located roughly 15 Mpc away:

- Gravitational constant ($G$) is $6.674 \times 10^{-11}$ m$^3$ kg$^{-1}$ s$^{-2}$.
- Distance to the centre of mass ($R$) is roughly 15 Mpc away from the Milky Way, which converts to $\approx 4.63 \times 10^{23}$ meters.

We solve for the required mass ($M$) using the standard acceleration formula as follows:

$$a_{\text{local}} = \frac{GM}{R^2}$$

$$M = \frac{a_{\text{local}} R^2}{G}$$

$$M = \frac{(7.62 \times 10^{-13}) \times (4.63 \times 10^{23})^2}{6.674 \times 10^{-11}}$$

$$M \approx 2.45 \times 10^{45} \text{ kg}$$

When we convert $2.45 \times 10^{45}$ kg into solar masses (where $1M_\odot \approx 1.989 \times 10^{30}$ kg), the required mass to resolve the Hubble tension is:

$$1.23 \times 10^{15} M_\odot$$

Mainstream astronomical consensus places the total mass of the Local Supercluster within the range of $1.0 \times 10^{15}$ to $2.0 \times 10^{15} M_\odot$. The fact that this first-principles derivation so perfectly aligns with the Local Supercluster's observed mass represents a validation of the ETF interpretation of the mechanics of the Hubble flow when embedded within a non-homogenous cosmic acceleration floor.

The calculation result sits precisely at the accepted observational mass of the Local Supercluster. The physical presence of a $1.23 \times 10^{15} M_\odot$ structure at an effective local radius of 15 Mpc generates the required increase in the acceleration profile to push the local Hubble reading from the unperturbed baseline up to the SH0ES team's measurements. The Hubble tension is a localised metric anomaly perfectly predicted by the cosmic 3D isotropic acceleration floor as described in the ETF paradigm.

## 12. The Bullet Cluster and Weak Lensing

MOND struggles to explain weak lensing in massive structures like the Bullet Cluster, leaving standard cosmology to rely on invisible dark matter halos to provide the missing mass. However, in the ETF, we do not need dark matter. Just as the $a_0$ value sets a minimum acceleration threshold for matter in 2D galactic disks, the $a_F$ floor sets a minimum acceleration threshold in 3D structures. As noted earlier, the rate of proper time at any point in the ETF rests upon the power flux at that point. Therefore, localized energy transformation actively distorts the time field, which in turn curves the spatial metric.

In the Bullet Cluster, where two massive galaxy clusters have collided, the stars and solid bodies passed through each other seamlessly, but their immense, associated gas clouds collided violently at roughly 4,500 km/s and decelerated. Because the gas contains most of the clusters' baryonic mass, this collision physically separated the bulk of the visible mass from the galaxies, leaving the gas trailing behind in the collision zone. Yet, weak lensing reveals that the primary gravitational curvature did not remain with the mass of the gas; it continued forward, remaining perfectly coincident with the collisionless stars in the galaxies. Standard models attribute this to a halo of invisible, collisionless dark matter traveling with the stellar cores.

The ETF explains this entirely through metric stiffness. The acceleration floor is responsive to the presence of mass and energy ($E = mc^2$). When the acceleration floor is severely disrupted by a colossal merger event, the metric cannot immediately return to its pre-stressed state. In standard ΛCDM, the metric is assumed to instantaneously track the baryonic mass and return to flat spacetime once a mass has moved past a point. In the ETF, however, the manifold possesses metric stiffness. The intensely curved metric established over billions of years around the dense galactic cores cannot instantly relax and redistribute its geometry to track the violently arrested gas. The baseline acceleration floor of the surrounding void acts as a constraining medium, meaning there is a distinct thermodynamic relaxation time associated with any massive perturbation.

This metric stiffness mimics the exact gravitational properties of dark matter. Light passing through a region where the metric is stiffer than the surrounding metric stiffness is refracted identically to the way light is by a massive physical object. If there is any doubt regarding this interpretation, consider how the bending of starlight around the Sun was originally calculated by Einstein

$$\alpha_{GR} = \frac{4GM}{bc^2}$$

This exact result (1.75 arcseconds in his specific calculation) can be seamlessly replicated using the ETF's premise that energy transformation within matter achieves the same geometric curvature via the Planck power limit ($P_L = c^5/G$). By substituting $G = c^5/P_L$ into the deflection equation, the deflection angle is reframed entirely in terms of power flux and energy density

$$\alpha_{ETF} = \frac{4(c^5/P_L)M}{bc^2} = \frac{4Mc^3}{bP_L}$$

In the Bullet Cluster, the metric remains deeply curved around the galaxies because of the immense energetic disruption of the merger and the finite thermodynamic relaxation time required for the fabric of spacetime to return to the macro baseline of the region. No extra dark matter mass is required. The observed weak lensing is explained fully within existing physics by accounting for metric stiffness.

This explanation does not replace the accepted ‘mass curves spacetime’ narrative of General Relativity; it instead extends it. It ensures that extreme disruptions to spacetime on a macro scale must take into account the metric stiffness of the manifold.

## 13. Rethinking Time and Gravity

One of the most profound paradigm shifts arising from the ETF is the proposition that gravity is the curvature of the time field, rather than a mysterious force requiring a theoretical graviton. Theorists like Verlinde (Entropic Gravity) and Rovelli (Loop Quantum Gravity) have spent decades searching for deep quantum mechanics that project a macroscopic phenomenon that can be reconciled with gravity. The ETF fundamentally departs from this approach. By taking a reductionist stance on the nature of energy and time, the framework suggests a far simpler reality: gravity is the geometric output of energy translating into time.

Within the ETF, time is elevated from a passive dimension to an active field, possessing a specific proper time rate at every point in the cosmos that is dictated by the local power flux. Energy transformation and time act as conjugates; the higher the power flux at any given point, the slower the rate of proper time. Central to this mechanism is the role of mass-bearing particles, which interact with the Higgs field to uniquely generate quantum action cycles. These cycles act as continuous engines of energy-to-time nucleation. Because the speed of light ($c$)

is finite and fixed, this nucleated time must physically express itself as spatial geometry ($dx = c \cdot dt$). When considered across the entirety of the cosmos, this continuous outward flow of nucleated time packets actively drives the expansion of the universe, entirely removing the need for a cosmological constant or dark energy.

While $c^5/P_L$ does not constitute a traditional derivation of the gravitational constant $G$, which remains an empirical measurement, it intimately connects Planck power to the absolute geometric limits of the universe. In "Deriving Spacetime Metrics From the Principle of Energy-to-Geometry Translation Through an Active Metric Engine," we proposed replacing General Relativity's static rubber-sheet analogy with a dynamic model of energy peaks residing within a cosmic-wide time field. The immense volume of quantum action cycles within a massive object creates a concentrated energy peak, natively slowing the local proper time rate.

By rooting the metric in the power flux of quantum action cycles, we were able to derive two foundational mathematical pillars of standard physics—the Lorentz factor and the Schwarzschild radius—directly from first principles and Planck power. This demonstrates that relativistic kinematics and gravitational boundaries are not merely abstract geometric constructs, but the inevitable, thermodynamic requirements of a universe fundamentally shaped by the continuous translation of energy into time.

As nucleated geometry flows outward from these energy peaks into the unperturbed background time field, it creates a macroscopic gradient. In this view, matter is not "pulled" by a gravitational force; rather, obeying a thermodynamic reinterpretation of the Principle of Least Action, matter simply follows the path of least energetic requirement through the time field's curvature. This outward flow of geometry perfectly accounts for the expanding manifold between non-gravitationally bound objects, while preserving the kinematic effects observed within gravitationally bound systems. In this model, the discrete quantum action cycles at the microscopic scale are thus bridged with the large-scale macroscopic continuum limit of General Relativity.

## 14. Energy Conservation at Cosmic Scales

Upending the current view of the cosmos in which all physical activity takes place upon a pre-existing blank canvas of time, and replacing it with one in which time and geometry are the active output of energy transformations leads to profound philosophical and scientific implications.

This new interpretation requires that energy not only be conserved at the microscale, but that it must ultimately be conserved at the cosmic scale. In General Relativity, global energy conservation is not a universal law but a conditional outcome dictated by Noether's theorem; because the expanding spacetime metric lacks time-translation symmetry, total cosmic energy is neither conserved nor definable.

However, consider this idea in terms of a photon. Conventionally, we would say a photon loses energy as it traverses a great distance from the source to the receptor, reflected in its redshift. This observation underpins the mainstream idea that energy is not conserved at cosmic scales. But this may not be the correct way to think about this interaction. A photon does not possess rest mass and travels on a null geodesic ($ds = 0$). Therefore, it cannot nucleate quantum action cycles. It cannot dynamically exchange energy and gradually degrade while continuing on its way; it either exists as an idealized, fixed quantum energy state, or it does not. From the point of nucleation to the point of subsequently interacting with a mass-bearing particle, a photon's existence is a single contiguous instant in which for the photon $\Delta t = 0$. From its own frame of reference, no time passes that would allow it to lose energy, an idea enforced by the concept of time and energy transformation being conjugate. Instead, within the domain inhabited by mass-bearing observers, the fabric of spacetime has stretched. From our observer's perspective where $ds \neq 0$, because we measure the photon's energy level over a fixed time window (in Hz), the energy level does indeed appear to have dropped.

At this point, we must re-evaluate the thermodynamic boundaries of the cosmos. Noether's theorem requires symmetry for energy to be conserved. If the metric is treated merely as a passive mathematical grid, that symmetry is broken by expansion. However, in the ETF, the metric is a physical, thermodynamic participant. The expanding spacetime itself stores and accommodates this energy density shift.

In the ETF, cosmic expansion is the direct result of quantum action cycles that, when summed across the entire cosmos, yield Planck power. It is a universe that is adiabatic, conservative, and isentropic. For a system to remain adiabatic and isentropic, information such as pressure, temperature, and density must be exchanged. The rate at which this information can be exchanged is limited by the speed of causality ($c$). This sets a maximum causal boundary for all systems in which information can be exchanged in time to effect a physical outcome that can be considered systemically adiabatic. Standard General Relativity cannot enforce global conservation precisely because it attempts to look across domains separated by these causal boundaries. However, the cosmos is constituted from countless overlapping causal horizons which, when summed up, yield a conservative whole.

If the cosmos were not globally conservative, the 2D ($a_0$) and 3D ($a_F$) acceleration floors derived from Planck power would not exist. In mainstream cosmology, theorists demand the addition of massive dark matter halos to account for these empirical limits. In the ETF, overcoming the active, outward expansion rate of this closed thermodynamic system sets the fundamental acceleration floor a mass must overcome if it is to be spatially displaced.

**15. Resolving the Vacuum Catastrophe**

In standard cosmology, the vacuum catastrophe is widely considered the worst theoretical prediction in the history of physics. Quantum Field Theory mathematically calculates the vacuum of space to be a boiling sea of zero-point energy. When mainstream physicists attempt to apply General Relativity to this mathematical vacuum energy to explain cosmic expansion, the resulting value is roughly $10^{120}$ times larger than the observed cosmic density of approximately $10^{-}27kg/m^3$. To bridge this enormous gap, standard physics has spent decades hypothesizing complex mathematical cancellations, unnatural fine-tuning, or anthropic multiverses.

The ETF argues that the immense vacuum energy predicted by QFT is a computational artifact—the result of extrapolating mathematical harmonic oscillators beyond their physical boundaries. While phenomena such as the Casimir effect are routinely cited as proof of physical vacuum energy, work by physicists like Julian Schwinger has long demonstrated that these effects can be entirely derived from the physical interactions of source matter, requiring no latent vacuum energy at all.

In the ETF, spacetime is not a pre-existing container holding latent quantum energy. Instead, space is the thermodynamic exhaust of discrete quantum action cycles processed by mass-bearing matter. While the manifold exhibits granularity at the quantum level, the empty space itself is a geometric output, completely devoid of intrinsic, gravitating energy. By stripping the vacuum of this mathematical artifact and returning the mechanics of expansion to the Planck power output of real, mass-bearing matter, the vacuum catastrophe vanishes entirely. The expanding cosmos is dictated by the density and thermodynamic limits of observable matter, requiring no dark energy or mathematical cancellations to maintain its stability.

**16. Towards a Simpler Universe**

The ETF represents a new way of looking at the cosmos. At its core, the framework challenges the block universe by introducing the idea that time is created from energy transformation, which in turn translates into geometry, ultimately yielding an expanding cosmos. Planck power is identified as the sum of all quantum action cycles within the cosmos, fixed at $3.6 \times 10^{52}$ watts, reflecting the fixed total mass-energy of the cosmos. Rather than a blank, passive canvas upon which physical events play out, this model imbues the manifold with a property we call 'metric stiffness,' which is mapped directly from the acceleration floor. Metric stiffness mimics exactly the kinematic properties of dark matter. Therefore, in the Emergent Time Framework, the expanding cosmos (currently attributed to dark energy) and the anomalous kinematics of matter (currently attributed to dark matter) are united as manifestations of a single geometric property: Planck power. This greatly simplifies the cosmos and our understanding of how it has developed and how it works.

This model challenges some of the most revered pillars of modern cosmology and physics, but in the final analysis, it relies on existing physics to answer some of the most difficult open questions within the field. The field equations of General Relativity will still stand unchallenged as providing the macroscopic fluid limit of the underlying quantum action cycles that define its deep, underlying mechanics at the microscale. But we should ask ourselves how Nature comes to operate flawlessly at every scale imaginable without the requirement for ad-hoc parameters or singularities?

The ETF is a very new paradigm, and it demands much further theoretical work to validate some of its foundational claims. General Relativity has served science exceedingly well over the last century, and the subsequent ΛCDM model has provided a robust framework for recent decades. However, it is the considered view of this author that, taken together, they no longer offer a complete explanation of what we observe—especially now that observational tools like JWST and ALMA have been developed to such a high degree. General Relativity required a cosmological constant to be bolted onto the generalized field equations to explain the expanding universe; dark matter halos are required to explain why gravity behaves differently at the macro scale. Inflation theory is required to explain away the cosmological flatness problem—the 1 part in $10^{62}$ chance the early cosmos existed with the exact density required to form our current universe—with those extreme odds already pointing to a fundamental disconnect between Nature and our understanding of it. General Relativity yields a singularity at the centre of black holes, an 'unphysical' state that we struggle to reconcile with reality. These and other nagging anomalies strongly suggest that we need to fundamentally rethink our current mainstream descriptive models.