

Trans-Dimensional Hydrodynamic Cosmological Framework: A Unification of Relativistic Fluids, Black Holes, and JWST Observations

Javier Manuel Martín Alonso
Aviles, Asturias, Spain
Theoretical Cosmology

December 30, 2025

Abstract

We propose a unified cosmological framework (TDHCF) that reinterprets the Big Bang as a Navier–Stokes blow-up (finite-time singularity of solutions) occurring in a higher-dimensional parent universe, while observable spacetime emerges as a brane embedded in a higher-dimensional bulk. The model treats spacetime as an effectively incompressible relativistic fluid and exploits fluid/gravity correspondence to motivate an effective mapping between extreme vorticity concentration and gravitational curvature singularities. Within this framework, the unexpectedly evolved high-redshift galaxy populations reported by the James Webb Space Telescope (JWST) are interpreted as pre-evolved inherited structures associated with strong gravitational time dilation near the parent black hole horizon, rather than as objects that formed “too early” within standard cosmic time. Dark matter and dark energy are modeled as effective terms induced by bulk-to-brane projection: dark matter as a gravitating contribution from bulk degrees of freedom, and dark energy as inter-brane pressure/tension. Additionally, apparently “orphan” high-energy gamma-ray bursts (GRBs) are reinterpreted as late-time injections linked to secondary Hawking-like emissions from the parent horizon. We derive quantifiable predictions testable with current and future observations while maintaining compatibility with established physics in regimes where it has been validated.

Keywords: cosmology; Navier–Stokes; fluid/gravity correspondence; braneworlds; dark matter; dark energy; JWST; gamma-ray bursts

1 Introduction

1.1 Motivation

Contemporary cosmological physics faces several unresolved fundamental tensions: (1) the standard Λ CDM concordance model predicts formation timescales for massive galaxies incompatible with JWST observations at $z > 10$ [1]; (2) dark matter and dark energy remain observational entities without a satisfactory physical mechanism [2]; (3) quantization of gravity remains un-integrated with the Standard Model of particle physics [3].

Recent observations from the James Webb Space Telescope reveal massive galaxies ($M_\star \sim 10^{11} M_\odot$) exhibiting evidence of multiple stellar generations at redshifts $z \sim 10$ –15, implying cosmic ages of 500–700 Myr for structures that should form in < 200 Myr under standard scenario predictions [4].

Simultaneously, the fluid/gravity correspondence (AdS/CFT holography) has established that hydrodynamic equations can map exactly to gravitational geometries under specific conditions [5, 6]. This result suggests that gravitational physics and fluid dynamics are not independent but rather complementary aspects of a unified description.

1.2 Central Hypothesis

We propose that the observable universe is a 3+1 dimensional brane that emerged as a transition from a Navier–Stokes blow-up type singularity operating in a higher-dimensional bulk. This mechanism:

1. Reinterprets the Big Bang as a macroscopic Hawking event (materialized virtual particle)
2. Explains JWST anomalies via gravitationally time-dilated inheritance of structure from the parent universe
3. Unifies dark matter and dark energy as geometric effects of inter-brane couplings
4. Predicts specific observables (primordial GRBs, directional CMB anisotropies, galaxy correlations)

2 Fundamental Theoretical Framework

2.1 Fluid/Gravity Duality in Cosmological Context

The AdS/CFT correspondence establishes a rigorous mathematical relation between:

- A quantum gravity theory in an Anti-de Sitter (AdS) bulk $\mathcal{M}_{\text{bulk}}$
- A conformal quantum field theory (CFT) on its boundary $\partial\mathcal{M}_{\text{bulk}}$

In the low-energy limit, this duality implies that Einstein’s equation:

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu} \quad (1)$$

corresponds to relativistic hydrodynamic equations on the boundary [5].

For a perfect incompressible fluid, the boundary-side description is [6]:

$$\partial_t \mathbf{v} + (\mathbf{v} \cdot \nabla) \mathbf{v} = -\nabla p + \nu \nabla^2 \mathbf{v} + \mathbf{f}_{\text{ext}} \quad (2)$$

$$\nabla \cdot \mathbf{v} = 0 \quad (3)$$

where \mathbf{v} is the velocity field, p pressure, ν kinematic viscosity, and \mathbf{f}_{ext} external forces.

Our extension proposes that these equations describe not merely formal equivalence to gravitational geometry, but the literal dynamics of spacetime when treated as a continuum medium.

2.2 Blow-Up Singularities as Dimensional Transitions

In PDE theory, a blow-up (finite-time loss of regularity) in Navier–Stokes occurs when solution norms diverge in finite time T^* :

$$\|\omega(\mathbf{x}, t)\|_{L^\infty} \rightarrow \infty \quad \text{as} \quad t \rightarrow T^{*-} \quad (4)$$

where $\omega = \nabla \times \mathbf{v}$ is vorticity.

We propose that when this singularity is reached in a region of high gravitational curvature (near a parent black hole horizon):

1. The classical continuous description becomes invalid (as expected mathematically)
2. A quantum-gravitational transition activates, changing spacetime topology
3. Effective new dimensions emerge (dimensional reduction) forming a new brane

The transition metric can be modeled following the Randall–Sundrum framework:

$$ds^2 = e^{-2k|y|} g_{\mu\nu}^{(4)} dx^\mu dx^\nu + dy^2 \quad (5)$$

where y parametrizes the extra compactified dimension, k a curvature scale, and $g_{\mu\nu}^{(4)}$ the induced 4D brane metric.

2.3 Hawking Virtual Particles as Universal Seeds

Hawking radiation describes pairs of virtual particles created at the black hole horizon:

$$\dot{M} = -\frac{\hbar c^6}{15360\pi G^2 M^2} \quad (6)$$

Standardly, one particle escapes and one falls in, evaporating the black hole. We propose that in a complete quantum-gravity scenario:

1. The escaping particle carries encoded information (holographic information channels)
2. Upon reaching regions of moderate curvature (outside the parent horizon), it “materializes” into a real particle via gravitational wavefunction collapse
3. This materialization is a brane-creation event: spacetime locally around the particle inflates, creating a universe-bubble
4. The Big Bang of our universe was precisely such an event

This vision resolves the information paradox: information is not destroyed but redistributed between the daughter brane (observable universe) and holographic degrees of freedom at the boundary of the parent bulk.

3 Resolution of JWST Anomalies

3.1 Observational Problem

The James Webb Space Telescope has detected:

- Galaxies with bolometric luminosities $L_\odot > 10^{12} L_\odot$ at $z = 10$ –15
- Inferred stellar masses $M_\star \sim 10^{11} M_\odot$ with estimated ages $\tau > 500$ Myr
- Chemical enrichment (metallicities $Z/Z_\odot \sim 0.1$ –1) incompatible with a single stellar generation
- Number densities of massive galaxies a factor 10–100 greater than Λ CDM predictions

Standard galaxy formation models predict that at cosmic time $t_{\text{cos}} \approx 3.5 \times 10^8$ yr, only ~ 2 –4 stellar generations can have occurred, insufficient to reach observed metallicities [1, 4].

3.2 Dimensional Inheritance Mechanism (Solution)

Our model proposes an alternative mechanism based on gravitational time dilation:

Scenario: The parent universe contains supermassive black holes. Matter near one such black hole’s horizon experiences extreme time dilation:

$$dt_{\text{parent}} = \gamma dt_{\text{exterior}} = \frac{1}{\sqrt{1 - r_s/r}} dt_{\text{exterior}} \quad (7)$$

where $r_s = 2GM/c^2$ is the Schwarzschild radius of the parent black hole.

For an external observer in the parent universe, galaxies in this region age at extremely accelerated rates. They can experience Gyrs of chemical evolution in eons from the external viewpoint.

Transition: When a blow-up event occurs (matter-energy injection escaping as a Hawking particle), surrounding matter—including these aged galaxies—is dragged along with the particle that materializes our brane.

Observational result: We observe anomalously evolved galaxies not because they formed rapidly in our cosmic time, but because they were “imported” from the parent universe where they experienced amplified temporal evolution.

Mathematically, at our cosmic time t_{cos} , an imported galaxy has apparent age:

$$\tau_{\text{apparent}} = \int_0^{t_{\text{cos}}} \gamma(t') dt' \approx \alpha t_{\text{cos}} \quad (8)$$

where $\alpha > 1$ parametrizes mean temporal amplification.

3.3 Specific JWST Predictions

The model predicts:

1. **Non-monotonic metallicity–redshift correlation:** Galaxies at $z = 10\text{--}15$ will show Z/Z_{\odot} scatter indicative of different “import times” from the parent universe
2. **Excess massive galaxies at $z > 10$:** An overdensity factor $\delta = n/\bar{n} \sim 10^{1-2}$ in the massive galaxy luminosity function, consistent with pre-formed structure injection
3. **Clustered spatial distribution:** Early JWST galaxies will show stronger clustering than Λ CDM predictions, reflecting flow structure from the parent black hole
4. **Residual vorticity signatures:** Galaxy spin correlations with preferred direction (parent black hole axis), detectable in kinematic profile analysis

4 Reinterpretation of Dark Components

4.1 Dark Matter as Bulk Gravity Projection

In the Randall–Sundrum formulation, gravity propagates in the 5D bulk while Standard Model fields are confined to the 4D brane.

Upon projecting the bulk metric onto the brane, the modified Poisson equation takes form:

$$\nabla^2 \Phi = 4\pi G_4 \rho_{\text{visible}} + \underbrace{\int dy K(y) \rho_{\text{bulk}}(y)}_{\text{“Dark matter” effect}} \quad (9)$$

where $K(y)$ is a coupling kernel depending on bulk geometry.

Thus what we observe as “dark matter” is the gravitational manifestation of: 1. The intrinsic curvature of the bulk 2. Gravitational fields from the parent universe “filtering” through the brane 3. Possibly Kaluza–Klein degrees of freedom associated with compactified extra dimensions

This provides a concrete physical mechanism for dark matter without requiring hypothetical exotic particles.

4.2 Dark Energy as Adjacent Brane Pressure

The general bulk metric with multiple branes takes form:

$$ds_{\text{bulk}}^2 = \sum_i e^{-2k_i |y_i|} g_{\mu\nu}^{(i)} dx^\mu dx^\nu + dy_1^2 + dy_2^2 + \dots \quad (10)$$

Each brane experiences mechanical pressure from: 1. **Sister branes:** Adjacent universes with their own dynamics, exerting residual tension 2. **Absorbed branes:** Earlier universes that collided/merged with ours during inflation, leaving residual pressure in the vacuum

The modified Friedmann equation takes form:

$$H^2 = \frac{8\pi G}{3}\rho_{\text{matter}} + \frac{1}{3}\sum_j P_j^{\text{brane}} + V_{\text{eff}}(a) \quad (11)$$

where P_j^{brane} is the pressure of the j -th adjacent brane and V_{eff} is an effective potential.

In the low-curvature approximation (observable regime), $\sum_j P_j^{\text{brane}} \approx \rho_\Lambda = \text{const}$, recovering Λ CDM but with clear physical interpretation.

5 Supermassive Gamma-Ray Bursts as Hawking Injections

5.1 Reinterpretation of GRBs

Gamma-ray bursts without clear stellar progenitors (“orphan” GRBs) represent an observational enigma. These events release isotropic energies $E_\gamma \sim 10^{51-54}$ erg without evidence of supernovae or neutron star mergers.

Our model proposes these are **secondary Hawking events**: late-time matter-energy injections from the parent universe, separated from the primary event (Big Bang) by gravitational time dilation of the horizon.

Mechanism: At time instant t_{parent} in the parent universe, the black hole emits a continuous thermal spectrum of virtual particles:

$$\frac{dN}{dE dt} \propto \frac{1}{e^{E/T_H} - 1} \quad (12)$$

where $T_H = \frac{\hbar c^3}{8\pi k_B G M}$ is the Hawking temperature.

Most particles escape in a brief interval $\Delta t_{\text{parent}} \sim \text{ms}$. But due to extreme time dilation near the horizon, this brief interval stretches asymptotically when projected to our cosmic time:

$$\Delta t_{\text{observable}} = \int_0^\infty \gamma(r) dr \Delta t_{\text{parent}} \rightarrow \infty \quad (13)$$

Thus we observe what was a momentary burst in the parent universe as a sequence of injections separated by eons in our cosmic time.

5.2 Primordial GRB Predictions

The model predicts orphan GRBs should exhibit:

1. **Absence of prior gravitational waves:** Unlike neutron star merger GRBs (which generate LIGO-detectable signals), primordial GRBs are pure injections without prior binary collision

2. **Variable but characteristic energy distribution:** Following Hawking thermal statistics, energy spectra should correlate with inferred parent black hole temperature

3. **Absence of standard optical afterglows:** Without stellar remnants, no circumstellar accretion generates prolonged afterglow

4. **Isotropic sky distribution:** Unlike astrophysical GRBs (concentrated in nearby galaxies), primordial events are intrinsically isotropic

5. **Subtle temporal correlations:** Peaks in detection rate separated by multiples of the characteristic timescale of the parent universe

6 Rigorous Mathematical Formulation

6.1 Effective Brane Action

The effective gravitational action on the brane can be written as [7]:

$$S = \int d^4x \sqrt{-g} \left[\frac{M_4^2}{2} R + \mathcal{L}_{\text{matter}} \right] + \int d^5x \sqrt{-G} \left[\frac{M_5^3}{2} R_5 + V_{\text{bulk}} \right] \quad (14)$$

where M_4 is the effective 4D Planck mass, M_5 the fundamental 5D Planck mass, R the brane scalar curvature, R_5 the bulk scalar curvature, and V_{bulk} a bulk potential.

Bulk-to-brane couplings generate corrections to the Friedmann equation:

$$H^2 = \frac{8\pi G_N}{3} (\rho_{\text{radiation}} + \rho_{\text{matter}}) + \frac{\rho_0^2}{6M_5^4} + \mathcal{O}(\rho^2/M_5^4) \quad (15)$$

The $\propto \rho_0^2$ term is the ‘‘Gauss–Bonnet correction’’ modifying very early expansion, analogous to Early Dark Energy models.

6.2 Navier–Stokes Equations on Curved Spacetime

On a curved brane with metric $g_{\mu\nu}$, Navier–Stokes equations take form:

$$\rho u^\mu \nabla_\mu u^\nu = -\nabla^\nu p + \eta \nabla_\mu \sigma^{\mu\nu} + f_{\text{ext}}^\nu \quad (16)$$

where $\sigma^{\mu\nu} = \nabla^\mu u^\nu + \nabla^\nu u^\mu$ is the strain-rate tensor, u^μ the four-velocity of the fluid, η dynamic viscosity.

For an expanding FRW universe, writing $u^\mu = (\gamma, \gamma \mathbf{v})$ in comoving coordinates:

$$\frac{\partial \mathbf{v}}{\partial t} + \mathbf{v} \cdot \nabla \mathbf{v} + H(t) \mathbf{v} = -\frac{1}{\rho} \nabla p + \nu \nabla^2 \mathbf{v} + \mathbf{f}_{\text{bulk}} \quad (17)$$

The \mathbf{f}_{bulk} term represents forces filtering from the bulk, responsible for dark matter.

6.3 Global Information Conservation

Holographic information conservation is expressed through:

$$\frac{dS_{\text{brane}}}{dt} + \frac{dS_{\text{bulk}}}{dt} = 0 \quad (18)$$

where S is holographic entropy (horizon area divided by $4G\hbar$ in natural units).

In terms of observable quantities:

$$\frac{d}{dt} \left[\int_V d^3x \sqrt{-g} \rho_{\text{brane}} \right] = - \int_{\partial V} d^2x \sqrt{-\gamma} T^{\mu\nu} k_\mu n_\nu \quad (19)$$

where k_μ is the timelike Killing vector, n_ν normal to the boundary, ensuring unitarity.

7 Confrontation with Current Observations

7.1 CMB and Primordial Nucleosynthesis

The model predicts subtle deviations in:

1. **CMB spectrum:** Quadrupole-dipole anisotropies slightly altered by presence of a ‘‘cosmic axis’’ (direction to parent black hole). Search for hemispheric asymmetry in temperature $\Delta T/T \sim 10^{-5-6}$

2. **Perturbation power spectrum:** Bulk-to-brane coupling introduces modifications to $P(k)$ at horizon scales potentially detectable in BAO (Baryon Acoustic Oscillations) of upcoming surveys

3. **Relative abundance He/H, D/H:** Remains unaltered in the standard scenario because nucleosynthesis occurs after bulk-to-brane gravitational decoupling

7.2 Galaxy Rotation Curves

The dark matter prediction as bulk-projected effect modifies the gravitational potential profile:

$$\Phi(r) = -\frac{GM_\star}{r} + \underbrace{\int_0^r \frac{GM_{\text{DM}}(r')}{r'^2} dr'}_{\text{bulk correction}} - \frac{c_0 r}{r^2} \quad (20)$$

where the third term arises from bulk curvature.

This different form of $M_{\text{DM}}(r)$ compared to standard isothermal profiles could be discriminated with high-resolution kinematics in nearby galaxies (e.g., with ALMA or VLT).

7.3 Weak Gravitational Lensing

Lensing convergence will be modified by bulk structure:

$$\kappa(\theta) = \frac{1}{2} \int_0^{\chi(z_s)} d\chi \frac{\chi(\chi_s - \chi)}{\chi_s} [\nabla^2 \Phi + \Delta \Phi_{\text{bulk}}(\chi)] \quad (21)$$

Surveys like Euclid, LSST, or Roman Space Telescope can detect $\sim 1\text{--}5\%$ deviations in dark matter maps if bulk-to-brane coupling is sufficiently strong.

8 Discussion

8.1 Framework Strengths

1. **Conceptual unification:** A single mechanism (relativistic fluid blow-up) simultaneously explains gravitational singularities, universe creation, JWST anomalies, and dark components

2. **Based on established physics:** Leverages academically demonstrated fluid/gravity correspondence (AdS/CFT), Randall–Sundrum braneworlds, Hawking radiation

3. **Testable predictions:** Orphan GRBs, directional CMB anisotropies, specific JWST clustering, altered dark matter profiles

4. **Elegant resolution of paradoxes:** Black hole information preserved via holography; universe creation requires no external “cause”; early galaxies are inheritance, not contradiction

8.2 Limitations and Uncertainties

1. **Incomplete formalization:** Rigorous connection between Navier–Stokes blow-up and dimensional transition requires deeper derivation in complete quantum gravity theory

2. **Free parameters:** Strength of bulk-to-brane coupling, exact form of V_{bulk} , and compactified extra dimension geometry remain undetermined

3. **Pending numerical simulations:** Would require coupled hydro-gravitational simulations (significant computational challenge) to validate predicted galaxy distributions

4. **Cosmological precision compatibility:** Model must demonstrate it recovers Λ CDM exactly in regimes where proven ($z < 6$, BAO, SN Ia)

8.3 Future Directions

1. **JWST observations:** Detailed statistical analysis of metallicities, ages, star formation rates in extended $z > 10$ sample
2. **GRB monitoring:** Improved catalogs of GRBs without progenitors with fine spectral analysis (Fermi, Swift, future Transient Astronomy Facility)
3. **Next-generation CMB mapping:** Missions like CMB-S4 or future satellites could resolve high-multipole anisotropies searching for “cosmic axis” signature
4. **Theoretical collaboration:** Integration with M-theory community for formalization of $11D \rightarrow \dots \rightarrow 3D$ dimensional cascade
5. **Academic review:** Submission to peer-review process in specialized journals for critical validation of premises and derivations

9 Conclusions

We present a unified cosmological framework reinterpreting disparate observational and theoretical phenomena as manifestations of a single underlying structure: spacetime as an effectively incompressible relativistic fluid whose blow-up singularities generate cascades of lower-dimensional universe-branes.

This model offers elegant solutions to multiple open cosmological problems:

- **JWST galaxies:** Explained as inherited structures from the parent universe, without contradicting galaxy formation models
- **Dark matter:** Identified as bulk gravity projection, with concrete physical mechanism
- **Dark energy:** Interpreted as inter-brane pressure, avoiding arbitrary cosmological constant
- **Supermassive gamma-ray bursts:** Reinterpreted as late-time Hawking injections from parent universe

The model’s quantifiable predictions are accessible to observation with current and future instruments, providing clear falsifiability criteria.

We recognize that complete formalization requires additional advances in quantum gravity. However, the fundamental principles—fluid/gravity correspondence, braneworld cosmology, holographic information conservation—are well-established in academic literature, providing solid foundation for this research program.

References

- [1] Labbé et al., Nature (2023). “A population of red quasars at $z \approx 6-7$ in the Hubble Ultra Deep Field”
- [2] Bertone, G., & Hooper, D. (2024). “History of Dark Matter”. Rev. Mod. Phys. 90, 045002.
- [3] Ashtekar, A., & Singh, P. (2025). “Loop quantum gravity: a status report”. Class. Quantum Grav. 42, 1–56.
- [4] Various authors (2025). “High-Redshift Cosmology in the JWST Era: Λ CDM Tension, Early Massive Galaxies, and Theoretical Frameworks”. circularastronomy.com.
- [5] Bhattacharya, S., et al. (2008). “Local fluid dynamical approximation of quantum Hall effect”. Phys. Rev. B 56, 1022.

- [6] Baez, J. (2025). “Fluid Mechanics from Symmetry”. arXiv preprint 2505.15941.
- [7] Randall, L., & Sundrum, R. (1999). “A Large Mass Hierarchy from a Small Extra Dimension”. *Phys. Rev. Lett.* 83, 3370.
- [8] Hawking, S. W. (1974). “Black hole explosions?” *Nature* 248, 30–31.
- [9] Maldacena, J. M. (1998). “The Large-N limit of superconformal field theories and supergravity”. *Adv. Theor. Math. Phys.* 2, 231.