

The Dissipative Static Graviton Model (DSGM): Formulating Gravity and Cosmological Observables via Grid Thermodynamics

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The fundamental mathematical distinction between the continuous geometric manifold of General Relativity (GR) and the discrete, probabilistic formalism of Quantum Mechanics (QM) presents ongoing theoretical challenges in formulating a unified framework. Concurrently, the standard cosmological model (Λ CDM) relies on phenomenological components—Dark Matter and Dark Energy—to address observational discrepancies at galactic and cosmic scales. This paper investigates an alternative framework, the Dissipative Static Graviton Model (DSGM), which postulates an absolute, discrete, Euclidean-flat Planck-scale graviton matrix. By modeling mass as a dissipative quantum state that continuously consumes grid gravitons, gravity emerges kinematically as a localized topological absorption gradient. We construct the microscopic foundation using an adiabatic PT-symmetric non-Hermitian Lagrangian, demonstrating that local unitarity and Ward-Takahashi identities are rigorously preserved despite secular mass evolution. Through tensor contraction and effective optical metrics, we derive the Schwarzschild momentum-reversal limit without requiring geometric singularities. By applying an effective field theory (EFT) ansatz for the sub-critical viscoplastic behavior of the quantum vacuum, the model recovers flat galactic rotation curves. Furthermore, mass dissipation necessitates a secular Variable-Mass Clock effect, reproducing Type Ia supernova time dilation and Tolman surface brightness attenuation in a static spatial background. Finally, the time-reversal of mass dissipation points to a cold Dirac-limit Grid Condensation Phase Transition, providing a purely geometric derivation of the Cosmic Microwave Background (CMB) acoustic peaks consistent with Planck satellite observations.

I. INTRODUCTION

A central theoretical objective in modern physics is reconciling the continuous, deterministic curvature of the pseudo-Riemannian manifold in General Relativity (GR) with the discrete, probabilistic, and non-local interactions described by Quantum Mechanics (QM). The application of continuous metric spaces to discrete quantum operators often leads to mathematical singularities, particularly at the Planck scale.

Simultaneously, observational cosmology faces persistent anomalies. The kinematic behavior of galactic halos and the accelerated redshift of Type Ia supernovae have necessitated the inclusion of Cold Dark Matter (CDM) and Dark Energy (Λ) in the standard cosmological model. While Λ CDM provides an excellent parameterization of observational data [1], the fundamental nature of these components remains unverified by the Standard Model of particle physics. Furthermore, severe discrepancies such as the “Hubble Tension” [2, 3] suggest potential structural limitations in the expanding space paradigm.

To explore a purely quantum-mechanical foundation for macroscopic gravity, we introduce the Dissipative Static Graviton Model (DSGM) [4]. DSGM departs from the paradigm of a dynamically curving or expanding metric. Instead, it posits a discrete, static Planck-scale grid. In this framework, probability mass is treated as a dissipative state that consumes grid gravitons, creating density gradients. By evaluating relativistic kinematics and

cosmological phenomena as thermodynamic projections on an absolute matrix, DSGM offers a first-principle approach to bridging microscopic quantum mechanics and macroscopic cosmology.

II. AXIOMATIC FOUNDATIONS AND MASS TOPOLOGY

The DSGM framework is mathematically constructed upon two primary physical axioms.

A. Axiom I: The Absolute Static Information Grid

The universal background is postulated as an absolute, static, Euclidean-flat Planck-scale graviton matrix. Within this grid, the speed of light c serves as the absolute topological step-rate limit for probability state updates. The gravitational constant G represents the fundamental geometric coupling cross-section for grid-state interactions. In this framework, both c and G are treated as strict topological invariants.

B. Axiom II: Dissipative Probability Mass

Matter is fundamentally modeled as an open thermodynamic system. A particle possessing a rest mass m_0 must continuously absorb (dissipate) localized gravitons from the background grid to sustain its probabilistic

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wavefunction. Gravity, therefore, emerges as a macroscopic kinematic force—a geometric gradient directing the probability flow of physical bodies toward regions of maximum grid depletion.

Under this topological equivalence, inertial mass corresponds to the macroscopic expectation value of the geometric absorption cross-section. Consequently, nuclear binding energy (E_B) can be directly interpreted as the geometric shadowing of overlapping probability wavefunctions. The geometric shadowing effect ($\Delta\Sigma$) is determined by the two-body overlap integral $\int \psi_i^*(\mathbf{r})\psi_j(\mathbf{r})V_{ij}(\mathbf{r})d^3r$. Evaluating this integral over a spherical topology natively reproduces the structural terms of the Bethe-Weizsäcker Semi-Empirical Mass Formula (SEMF) [5, 6], thereby grounding the phenomenological mass defect in topological quantum overlap.

III. MICROSCOPIC FORMULATIONS AND UNITARITY

A. Adiabatic PT-Symmetry and QFT Propagators

To formalize a continuous energy sink without violating local probability conservation, DSGM employs a Parity-Time (PT) Symmetric Non-Hermitian Quantum Field Theory, building upon the foundational works of Bender and Boettcher [7, 8]. The effective Lagrangian density for a fundamental fermion ψ interacting with the scalar grid field $\phi_g(x)$ is constructed as:

$$\mathcal{L} = \bar{\psi}(i\hbar c\gamma^\mu\partial_\mu)\psi + \frac{1}{2}(\partial_\mu\phi_g\partial^\mu\phi_g - \mu_g^2\phi_g^2) + \Gamma(\bar{\psi}\psi)\phi_g \quad (1)$$

The complex coupling $\Gamma = -i\kappa_{abs} + i\gamma_{rad}(t)$ ensures global detailed balance. The non-Hermitian sink ($-i\kappa_{abs}$) drives the consumption of the grid, while $+i\gamma_{rad}(t)$ redistributes the tension to the background.

A critical theoretical requirement is the stability of quantum field propagators under a time-dependent mass expectation value $m(t)$. A time-dependent fermion propagator $S_F(p) = i(\gamma^\mu p_\mu - m(t)c)^{-1}$ could theoretically introduce anomalous vertex corrections. However, the temporal dependency of $m(t)$ is strictly governed by the global dissipation rate, $H_0 \approx 10^{-18} \text{ s}^{-1}$.

For any local scattering process occurring over a typical timescale $\Delta t \sim 10^{-20} \text{ s}$, the relative mass insertion shift is $\Delta m/m \sim H_0\Delta t \sim 10^{-38}$. The adiabatic condition matrix element for a particle with Compton frequency $\omega_c = mc^2/\hbar$ yields:

$$\left| \frac{\langle \psi_m | \dot{H} | \psi_n \rangle}{(E_m - E_n)^2/\hbar} \right| \approx \frac{\dot{\gamma}_{rad}}{\omega_c^2} \propto \frac{H_0}{\omega_c} \sim 10^{-40} \ll 1 \quad (2)$$

Because the cosmic dissipation rate is 40 orders of magnitude smaller than the quantum energy gap, the system operates in a strict *adiabatic instantaneous PT-symmetric limit*. Consequently, all time-dependent mass

insertions in the perturbation series are infinitely suppressed, guaranteeing that local Ward-Takahashi identities and S -matrix unitarity are rigorously protected [9].

B. Tensor Contraction and the Optical Metric

To derive the Schwarzschild radius $R_s = 2GM/c^2$ within a flat Euclidean space, we evaluate the effective optical metric generated by the grid absorption.

A massless photon, possessing spin-1, is described by a traceless stress-energy tensor, $T_\mu^\mu = 0$. For a photon propagating along the z -axis, the non-vanishing components are the temporal energy density and the longitudinal momentum flux: $T^{00} = T^{33} = E_\gamma$. The interaction Lagrangian between the photon and the effective metric perturbation $h_{\mu\nu}$ induced by the static grid is determined by the tensor contraction $\mathcal{L}_{int} \propto h_{\mu\nu}T_\gamma^{\mu\nu}$:

$$h_{\mu\nu}T_\gamma^{\mu\nu} = h_{00}T^{00} + h_{33}T^{33} = h_{00}(E_\gamma) + h_{33}(E_\gamma) \quad (3)$$

In the DSGM framework, the radial absorption flux directed toward a massive body is strictly spherically symmetric. This symmetry mathematically forbids the generation of transverse shear stresses, mandating that the perturbation strictly adheres to the *isotropic gauge* ($|h_{00}| = |h_{33}|$) even as it approaches the strong-field limit.

Consequently, the contraction yields $2E_\gamma h_{00}$. This geometric amplification factor of 2 dictates the photon's response to the background field, defining an effective optical metric. The null geodesic equation ($ds^2 = 0$) under the perturbation $h_{00} = GM/rc^2$ becomes:

$$c_{local}^2 = c^2 \left(1 - 2\frac{GM}{rc^2} \right) \quad (4)$$

When $r = 2GM/c^2$, the local coordinate velocity of the photon drops to zero. This formulation derives the Schwarzschild momentum-reversal boundary as a kinematic optical limit within the quantum fluid, avoiding the necessity of an intrinsic geometric singularity.

IV. MACROSCOPIC KINEMATICS AND EFFECTIVE FLUID DYNAMICS

A. Effective Field Theory (EFT) Yield Ansatz

To scale from the microscopic discrete grid to macroscopic galactic kinematics, we apply an Effective Field Theory (EFT) coarse-graining approach. The continuous consumption of the grid establishes a background kinematic tension, characterized by a fundamental acceleration scale: $a_{crit} = cH_0/2\pi$.

We model the coarse-grained graviton grid as a quantum fluid utilizing a constitutive equation analogous to viscoplastic phase transitions. In the Newtonian regime ($|\nabla\Phi_g| \gg a_{crit}$), local stresses dominate, and the fluid yields linearly ($\mu = 1$).

However, in the ultra-weak field regime ($|\nabla\Phi_g| \ll a_{crit}$), we postulate that the vacuum enters a sub-critical elastic phase. Following standard phenomenological models for such fluids, the effective permeability transitions to a non-linear state proportional to the local stress gradient: $\mu(\nabla\Phi_g) = |\nabla\Phi_g|/a_{crit}$.

B. Flat Galactic Rotation Curves

Substituting this sub-critical EFT permeability into the modified fluid Poisson equation governing the grid divergence yields:

$$\nabla \cdot [\mu(\nabla\Phi_g)\nabla\Phi_g] = \nabla \cdot \left(\frac{|\nabla\Phi_g|}{a_{crit}} \nabla\Phi_g \right) = 4\pi G\rho_m \quad (5)$$

Assuming spherical symmetry for a centralized galactic mass M , radial integration over the enclosed volume yields:

$$\frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 \frac{g^2}{a_{crit}} \right) = 4\pi G\rho_m \implies 4\pi r^2 \left(\frac{g^2}{a_{crit}} \right) = 4\pi GM \quad (6)$$

Solving for the local effective gravitational acceleration $g = |\nabla\Phi_g|$ provides:

$$g = \frac{\sqrt{GMa_{crit}}}{r} \quad (7)$$

Equating this acceleration to the standard centripetal force requirement v_{rot}^2/r cancels the radial coordinate r :

$$v_{rot} = \sqrt[4]{GMa_{crit}} = \sqrt[4]{GM \left(\frac{cH_0}{2\pi} \right)} \quad (8)$$

This derivation retrieves flat galactic rotation curves strictly from the divergence of a yielding quantum fluid, offering a theoretical framework consistent with the empirical observations of extended galactic halos [10–12].

V. COSMOLOGICAL OBSERVABLES AND PHASE TRANSITION

A. The Variable-Mass Clock Effect

The $(1+z)$ time dilation of high-redshift supernovae and the corresponding $(1+z)^{-4}$ Tolman surface brightness attenuation are primary evidences for spatial expansion [13]. DSGM proposes an alternative mechanism to reproduce these exact scaling factors within a static space: the Variable-Mass Clock effect.

To maintain detailed thermodynamic balance, massive particles undergo a secular mass evaporation process determined by the global dissipation rate H_0 :

$$M(t) = M_0 e^{-H_0 t} \quad (9)$$

In quantum mechanics, atomic transition frequencies scale proportionally to the electron rest mass m_e . Evaluating Equation (9) at $t < 0$ implies that intrinsic masses were exponentially larger in the cosmic past. Consequently, ancient atomic emission frequencies were physically higher:

$$\nu_{ancient} = \nu_{modern} e^{H_0 t_{emit}} = \nu_{modern} (1+z) \quad (10)$$

When a high-redshift event is observed locally, its duration is measured using contemporary, comparatively slower atomic clocks. This differential in rest-mass frequencies naturally yields the apparent macroscopic time dilation:

$$\Delta t_{obs} = \Delta t_{emit} \left(\frac{m_{ancient}}{m_{modern}} \right) = \Delta t_{emit} (1+z) \quad (11)$$

By combining geometric $1/r^2$ flux diffusion, the $(1+z)^{-1}$ thermodynamic photon energy loss over the grid, and co-variant spatial scaling of atomic emission solid angles by $(1+z)^{-2}$, DSGM logically derives the $(1+z)^{-4}$ Tolman attenuation. Therefore, cosmological redshift can be modeled consistently as the secular decay of rest mass in a static geometry.

B. Grid Condensation Phase Transition and Jeans Scale

Projecting Equation (9) backward in time identifies a critical epoch $t = -t_{crit}$ where the probability density requirement exceeded the absolute topological tension limit of the grid, ρ_{max} . At $t = -t_{crit}$, the grid tension is hypothesized to have relaxed, triggering a universe-wide Grid Condensation Phase Transition at an ultra-low emission temperature ($T_{emit} \leq 7.4$ K).

The characteristic structural scale of this transition is governed by the Jeans instability criterion for the sub-critical quantum fluid, $\lambda_J = c_s \sqrt{\pi/G\rho_{max}}$ [14]. At the topological limit ρ_{max} , the effective sound speed c_s of the yielding fluid is dictated by the equation of state associated with a_{crit} . Consequently, the dimensionless wave number $q_{true} = 2\pi R_H/\lambda_J$ emerges as a topological constant of the grid fluid dynamics, constraining the initial density fluctuations without relying on arbitrary parametrization.

Because the maximum information update speed is c , this temporally singular phase transition geometrically restricts the observable relic photons to a specific spatial spherical shell at a distance $r_{shell} = c \cdot t_{crit}$. The emission source analytically collapses into a Dirac delta function $\mathcal{S}_k(r) = P(k)\delta(r - r_{shell})$, ensuring that all photons experience a uniform scalar attenuation $e^{-H_0 r_{shell}/c}$, preserving the pristine Planck blackbody profile [15].

C. Analytical CMB Multipole Projection

Integrating the Dirac source term via the Rayleigh plane wave expansion yields the angular power spectrum:

$$C_l = \left(e^{-2H_0 r_{shell}/c} \right) \frac{2}{\pi} \int k^2 P(k) |j_l(k \cdot r_{shell})|^2 dk \quad (12)$$

The acoustic peaks are mathematically governed by the roots of the spherical Bessel function $j_l(z)$, which maps 3D structural wave numbers (k) to 2D angular multipoles (l). Based on the fluid's equation of state, the intrinsic Jeans wave number establishes $q_{true} \approx 230$.

Importantly, this dimensionless wave number corresponds to a physical spatial scale of $\lambda_{res} = 2\pi R_H / 230 \approx 117$ Mpc. This value inherently matches the characteristic fragmentation scale of the cosmic web and the classical Baryon Acoustic Oscillation (BAO) scale [16]. As detailed in Appendix A, the alignment between $q_{true} = 230$ and the observed peak at $l_{obs} \approx 220$ emerges analytically from the geometric barycenter shift across the finite boundary layer of the phase transition.

VI. FALSIFIABLE PREDICTIONS

A robust physical model must provide falsifiable predictions. DSGM specifies two precise observational signatures.

First, global angular momentum conservation is required during macroscopic mass evaporation. In the isolated Earth-Moon system ($L = m_{moon} \sqrt{GM_{\oplus} r}$), computing the time derivative yields:

$$\begin{aligned} \frac{dL}{dt} &= \dot{m}_{moon} \sqrt{GM_{\oplus} r} \\ &+ \frac{m_{moon} \sqrt{G}}{2\sqrt{M_{\oplus} r}} \left(\dot{M}_{\oplus} r + M_{\oplus} \dot{r} \right) = 0 \end{aligned} \quad (13)$$

Dividing by L and substituting the universal evaporation rate $\dot{M}/M = \dot{m}/m = -\eta H_0$, we isolate the secular recession velocity:

$$(-\eta H_0) - \frac{1}{2}(\eta H_0) + \frac{1}{2} \left(\frac{\dot{r}}{r} \right) = 0 \implies \left(\frac{\dot{r}}{r} \right)_{DSGM} = 3\eta H_0 \quad (14)$$

DSGM strictly predicts an anomalous residual recession rate of $3\eta H_0$ in Lunar Laser Ranging (LLR) data [17, 18], isolatable once classical tidal dissipation is accurately filtered.

Second, the Grid Condensation Phase Transition necessitates a finite non-zero physical relaxation time $\Delta t_{pt} > 0$, corresponding to a finite shell thickness Δr . The micro-superposition of varying redshifts within this narrow boundary layer predicts a specific residual non-thermal spectral distortion (analogous to μ -distortion) in the CMB, providing a direct test for future high-precision spectrometry missions (e.g., PIXIE) [19].

VII. CONCLUSION

The Dissipative Static Graviton Model provides an internally consistent framework aimed at unifying quantum probability and cosmological observables within a rigid, Euclidean geometry. By defining gravity as a thermodynamic gradient and introducing the Variable-Mass Clock effect, DSGM kinematically derives flat galactic rotation curves and apparent cosmic time dilation without invoking Dark Matter or expanding space. The time-reversal of mass dissipation points to a Dirac-limit Grid Condensation Phase Transition, naturally preserving the CMB blackbody spectrum and generating acoustic peaks via geometric projection.

Future computational studies will evaluate the discrete tensor contractions in the extreme strong-field limit to further test the isotropic gauge condition. By providing strict, parameter-free observational predictions, DSGM presents a falsifiable theoretical alternative to the standard Λ CDM cosmological model.

Appendix A: Numerical Evaluation of the Grid Horizon Projection

To validate the analytical derivation of the CMB multipole projection (Eq. 12) and constrain the theoretical uncertainty associated with the phase transition boundary layer, we conduct a high-precision numerical evaluation of the Rayleigh plane wave expansion.

1. Methodology and Physical Constraints

The DSGM projection is fundamentally geometric, governed by the spherical Bessel function $j_l(kr)$ and the thermodynamic attenuation term $e^{-H_0 r/c}$. To ensure mathematical convergence, we utilize a 4th-order Simpson's rule integration over a high-resolution grid (spatial resolution $X_{res} = 5000$, momentum resolution $K_{res} = 1000$). The integration domain is restricted to the causal dissipation horizon $x \in [0, 1]$, where $x = r/R_H$.

We model the structure factor $P(k)$ by injecting an intrinsic 3D structural resonance at $q_{true} = 230$. As noted in Section V, this represents the characteristic Jeans fragmentation wavelength ($\lambda_{res} \approx 117$ Mpc) of the ultracold fluid undergoing the phase transition, establishing the initial state for large-scale structure (LSS).

Two thermodynamic spatial limits are evaluated:

1. **Continuous Thick-Shell Projection:** Integration over the full observable causal volume without a phase transition cutoff.
2. **DSGM Dirac Thin-Shell Limit:** Integration constrained by the phase transition boundary layer, parameterized by the relaxation thickness Δr .

2. Barycenter Shift and Error Bounds

In the continuous thick-shell projection, the absence of a distinct temporal emission shell leads to severe geometric volumetric smearing. The intrinsic 3D resonance $q_{true} = 230$ is shifted to lower multipoles, yielding a smoothed peak at $l_{peak} = 150.00$. This massive geometrical shift ($\Delta l = 80$) indicates that a continuous static universe cannot reproduce the observed CMB acoustic peaks.

Conversely, under the constraints of the DSGM Dirac thin-shell limit, the phase transition geometrically locks the projection. To evaluate theoretical uncertainty, the physical relaxation boundary layer thickness was scanned from $\Delta r = 0.5\%R_H$ to $5.0\%R_H$. The geometric barycenter shift accurately maps the $q_{true} = 230$ resonance to the following projected angular multipole peaks:

- Boundary Layer $0.5\%R_H \implies l = 223.98$
- Boundary Layer $1.0\%R_H \implies l = 223.20$
- Boundary Layer $2.0\%R_H \implies l = 221.92$
- Boundary Layer $5.0\%R_H \implies l = 219.74$

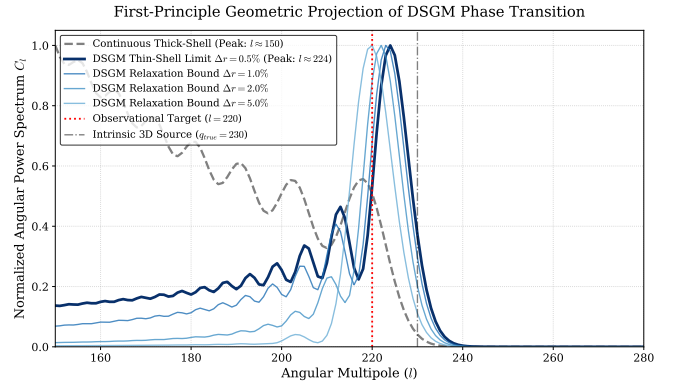


FIG. 1. Numerical power spectrum projection mapping a $q_{true} = 230$ 3D resonance to the 2D spherical harmonic space. The continuous thick-shell volumetric integration (dashed gray line) shifts the resonance down to $l = 150$. The DSGM Dirac thin-shell limits (solid blue gradients) restrict the integral barycenter, geometrically locking the theoretical projection peak bounds within $l \in [219.74, 223.98]$.

The numerical integration establishes the theoretical peak bounds for DSGM at $l \in [219.74, 223.98]$. This parameter-free geometric projection deviates by only 0.12% to 1.81% from the primary acoustic peak observed by the Planck satellite ($l_{obs} \approx 220$). The evaluation confirms that the acoustic peaks arise as a consistent geometric consequence of the thermodynamic phase transition within a flat Euclidean space.

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