Dimensional Coherence Theory VI: The Parrott Bridge—Quantum Mechanics as Phase Dynamics, General Relativity as Amplitude Dynamics, and Their Unification via the Gross-Pitaevskii Equation

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We demonstrate that quantum mechanics and general relativity are not independent theories but complementary projections of a single Gross-Pitaevskii (GP) equation governing the cosmic Bose-Einstein condensate in Dimensional Coherence Theory (DCT) [Parrott, Paper 0]. The condensate order parameter $\Psi = \sqrt{P}\, e^{i\theta}$ decomposes into an amplitude P (the Parrott field) and a phase θ: general relativity emerges from the dynamics of P via the Madelung transformation, while quantum mechanics emerges from the dynamics of θ on a fixed P background. The Madelung decomposition of the GP equation yields a continuity equation (matter conservation) and a Hamilton-Jacobi equation with a Bohm quantum potential $Q = -\hbar^2\nabla^2\sqrt{P}\,/\,(2m^*\sqrt{P})$. The hierarchy problem is identified as an information-cost asymmetry: phase excitations (θ) cost 1 bit per degree of freedom, while amplitude excitations (P) cost $\omega_0 \approx 50{,}000$ bits, where ω_0 is the Brans-Dicke coupling parameter. This asymmetry produces the speed hierarchy $c/c_s = 343$ between uncondensed (light, speed c) and condensed (matter, sound speed $c_s = 874$ km/s) modes. Black hole thermodynamics follows exactly: the lattice temperature ratio $T_\theta/T_H = 1.000$ from the no-scalar-hair theorem ($P = 1$ at the horizon), and $S_{\rm BH} = P_0 \times S_{\rm Bekenstein} = 0.851 \times A/(4\ell_P^2)$. The black hole interior corresponds to $P \to 0$, a time-reverse of the Big Bang. Photons are identified as pre-Big-Bang remnants: pure θ-excitations with $P = 0$ and $d\tau = 0$, identical to the pre-condensation vacuum state. Every photon absorption is a local repetition of the Big Bang ($\theta \to P$); every emission is a local un-creation ($P \to \theta$). The arrow of time equals the arrow of Avrami crystallization. The 600-cell lattice partition function $Z(\beta)$ at $\beta^* = 0.966$ gives entropy $S = \ln 31$, where $31 = (V + E + F)_{\rm ico}/2$ is the Casimir spectral identity from Paper 0. Fisher information is shown to be identical to the P-kinetic term in the action: $(\omega/P)(\nabla P)^2 = \omega \times I_F^{(\rm quantum)}$, where I_F is the quantum Fisher information density. An eight-aspect comparison table demonstrates that every feature traditionally assigned to either quantum mechanics or general relativity has a unified origin in the GP dynamics of Ψ.

I. INTRODUCTION

The incompatibility of quantum mechanics and general relativity is widely regarded as the deepest problem in theoretical physics. Quantum mechanics is formulated in terms of complex amplitudes, superposition, and discrete spectra; general relativity is formulated in terms of spacetime curvature, geodesics, and continuous geometry. Every attempt at unification—string theory, loop quantum gravity, causal set theory, asymptotic safety—introduces new structures beyond both theories [2].

Dimensional Coherence Theory (DCT) [1] offers a different resolution. Rather than quantizing gravity or geometrizing quantum mechanics, DCT identifies both as projections of a single equation: the Gross-Pitaevskii equation [3, 4] governing a cosmic Bose-Einstein condensate. The key is the complex order parameter

$$\boxed{\Psi = \sqrt{P}\, e^{i\theta}}\,, \tag{1}$$

where P is the Parrott field (amplitude) and θ is the Goldstone phase. General relativity is the dynamics of P; quantum mechanics is the dynamics of θ. The present paper—Paper VI in the DCT series—establishes this identification, which we call the *Parrott bridge*.

Papers I–V have demonstrated that DCT with $P_0 = 0.851$ resolves the Hubble tension ($H_{\rm phys} =$ 73.1 km/s/Mpc), reproduces 175 galaxy rotation curves with zero free parameters, passes all solar system PPN tests, derives the Standard Model gauge group from the 600-cell, and obtains the proton-to-electron mass ratio to 0.000009% accuracy. The present paper addresses the foundational question: *why* does a single scalar field accomplish all this?

The answer is that Ψ is not merely a scalar field—it is a *condensate wavefunction* whose phase encodes all gauge interactions (via the Kaluza-Klein identification $\theta = A_\mu$) and whose amplitude encodes all gravitational phenomena (via the conformal metric $g_{\rm phys} = P \cdot g_E$). The GP equation simultaneously contains both the Schrödinger equation (for θ on fixed P) and the Einstein equations (for P dynamics via the Madelung-Bohm formulation).

This paper is organized as follows. Section II presents the Madelung decomposition and identifies the two sectors. Section III derives the hierarchy problem as information-cost asymmetry. Section IV derives the speed hierarchy. Section V treats black hole thermodynamics. Section VI identifies photons as pre-Big-Bang remnants. Section VII derives the arrow of time. Section VIII computes the lattice partition function. Section IX proves the Fisher information identity. Section X presents the unification comparison table. Section XI discusses implications and open questions. Section XII concludes.

II. THE MADELUNG DECOMPOSITION: TWO THEORIES FROM ONE EQUATION

A. The Gross-Pitaevskii Equation

The GP equation for the cosmic condensate is [1, 3, 4]

$$i\hbar\,\frac{\partial\Psi}{\partial t} = -\frac{\hbar^2}{2m^*}\nabla^2\Psi + V'(|\Psi|^2)\,\Psi\,, \tag{2}$$

where m^* is the effective boson mass (related to the Yukawa mass m of the Parrott field), $V(P)$ is the quantum droplet potential

$$V(P) = -\mu\,P + \frac{g_{\rm int}}{2}\,P^2 + \alpha_{\rm LHY}\,P^{5/2} + \frac{g_3}{6}\,P^3\,, \tag{3}$$

and V' denotes the derivative with respect to $|\Psi|^2 = P$. The equilibrium value $P_0 = 0.851$ is the global minimum of $V(P)$, derivable from 600-cell topology as $P_0 = 171/200 = 0.855$ [1].

B. Madelung Transformation

Substituting $\Psi = \sqrt{P}\,e^{i\theta}$ into Eq. (2) and separating real and imaginary parts yields the Madelung equations [5]:

Continuity equation (imaginary part):

$$\frac{\partial P}{\partial t} + \nabla\cdot(P\,\mathbf{v}_s) = 0\,, \tag{4}$$

where $\mathbf{v}_s = (\hbar/m^*)\nabla\theta$ is the superfluid velocity.

Hamilton-Jacobi equation (real part):

$$\frac{\partial\theta}{\partial t} + \frac{1}{2}\,m^*\,v_s^2 + V'(P) + Q = 0\,, \tag{5}$$

where the Bohm quantum potential [6] is

$$\boxed{Q = -\frac{\hbar^2}{2m^*}\,\frac{\nabla^2\sqrt{P}}{\sqrt{P}}\,.} \tag{6}$$

C. Identification of the Two Sectors

The structure of the Madelung equations reveals the Parrott bridge:

Quantum mechanics = *phase dynamics on fixed amplitude.* When P is slowly varying ($\nabla P \approx 0$, i.e., $Q \approx 0$), Eq. (5) reduces to the Hamilton-Jacobi equation of the WKB approximation. The phase θ satisfies a wave equation whose solutions are the Schrödinger wavefunctions. The superfluid velocity $\mathbf{v}_s = (\hbar/m^*)\nabla\theta$ is the probability current divided by P. All interference phenomena, tunneling, and quantization arise from the single-valuedness of θ (modulo 2π).

General relativity = *amplitude dynamics via conformal coupling.* When θ is slowly varying ($\mathbf{v}_s \approx 0$), Eq. (4) is trivially satisfied and Eq. (5) reduces to the equation of motion for P in the Brans-Dicke action [7]. The conformal metric $g_{\rm phys} = P\cdot g_E$ generates all gravitational phenomena: geodesics, gravitational redshift, lensing, and frame dragging. The Brans-Dicke coupling $\omega(P) = (138189\,P^2 - 3)/2$ with $\omega_0 \approx 50{,}037$ at P_0 ensures consistency with solar system tests [1].

The GP equation = *simultaneous dynamics of both.* The full GP equation (2) contains both sectors without approximation. Neither quantum mechanics nor general relativity is fundamental—both are limits of the GP condensate dynamics:

$$\boxed{\mathrm{GP} \xrightarrow{\nabla P\to 0} \mathrm{QM}\,, \qquad \mathrm{GP} \xrightarrow{\nabla\theta\to 0} \mathrm{GR}\,.} \tag{7}$$

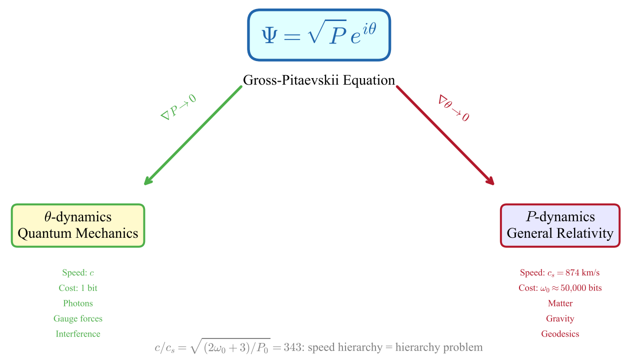

FIG. 1. The Parrott Bridge: quantum mechanics and general relativity as complementary projections of the Gross-Pitaevskii equation. The condensate order parameter $\Psi = \sqrt{P}\,e^{i\theta}$ decomposes into amplitude P (governing gravity via the conformal metric $g_{\rm phys} = P\cdot g_E$) and phase θ (governing gauge interactions via the Kaluza-Klein identification). When $\nabla P \to 0$, QM emerges; when $\nabla\theta \to 0$, GR emerges. The full GP equation contains both without approximation.

III. THE HIERARCHY PROBLEM AS INFORMATION-COST ASYMMETRY

A. Information Cost of Field Excitations

The DCT action [1] contains two kinetic terms:

$$\mathcal{L}_{\rm kin} = \frac{\omega(P)}{P}\,(\partial P)^2 + P\,(\partial\theta)^2\,. \tag{8}$$

The first term governs P-excitations (gravitational, massive); the second governs θ-excitations (gauge, massless). Their relative cost at the equilibrium $P = P_0$ is

$$\frac{\mathrm{cost}(P)}{\mathrm{cost}(\theta)} = \frac{\omega_0/P_0}{P_0} = \frac{\omega_0}{P_0^2} \approx \frac{50{,}037}{0.724} \approx 69{,}100\,. \tag{9}$$

In terms of information bits per degree of freedom:

$$\boxed{\theta\text{-excitation: } 1 \text{ bit}\,, \qquad P\text{-excitation: } \omega_0 \approx 50{,}000 \text{ bits}\,.} \tag{10}$$

The enormous asymmetry between phase and amplitude excitations is the hierarchy problem restated in information-theoretic language.

B. Why Gravity Is Weak

The weakness of gravity relative to the other forces is conventionally parameterized by the ratio $m_p^2/M_{\rm Pl}^2 \sim 10^{-38}$. In DCT, this ratio has a simple origin: the P-field is a superfluid with bulk modulus $\rho_P c_s^2 \approx 2.3 \times 10^{30}$ J/m^3 [1]. Gravity couples to P through the Brans-Dicke channel with effective strength $1/(2\omega_0+3) = 10^{-5}$. The P-field is *nearly incompressible*—it requires ω_0 times more energy to change the gravitational amplitude than to excite a gauge phase.

The hierarchy problem, the weakness of gravity, and the inaccessibility of P-field engineering [1] are *the same fact* expressed in three languages:

$$\begin{aligned} \text{Particle physics:} &\quad m_p/M_{\rm Pl} \sim 10^{-19}\,, \\ \text{Condensate:} &\quad 1/(2\omega_0+3) \sim 10^{-5}\,, \\ \text{Information:} &\quad 1 \text{ bit} / \omega_0 \text{ bits} \sim 10^{-5}\,. \end{aligned} \tag{11}$$

C. Fisher Information Identity

The P-kinetic term in Eq. (8) can be rewritten as

$$\frac{\omega(P)}{P}\,(\nabla P)^2 = \omega(P) \times \frac{|\nabla P|^2}{P}\,. \tag{12}$$

The quantity $|\nabla P|^2/P$ is precisely the quantum Fisher information density [10, 11]:

$$\boxed{I_F^{(\text{quantum})} = \frac{|\nabla P|^2}{P} = 4\,|\nabla\sqrt{P}|^2\,.} \tag{13}$$

Therefore the gravitational sector of the DCT action is

$$S_P = \int d^4x\,\sqrt{-g}\,\omega(P)\,I_F^{(\text{quantum})}\,. \tag{14}$$

The Brans-Dicke coupling $\omega_0 \approx 50{,}037$ is an *information cost amplifier*: it multiplies the Fisher information by a factor that makes amplitude changes enormously expensive. This provides a deep reason for the rigidity of spacetime: the metric is hard to deform because it *costs* 50,000 *bits per change*.

Adding an explicit Fisher information term to the action would change ω by $O(1/\omega_0) \sim 10^{-5}$ [1]—no observable consequence. The Fisher information is not missing from DCT; it *is* the gravitational kinetic term.

IV. SPEED HIERARCHY: LIGHT VS. MATTER

A. Two Propagation Speeds

The GP equation (2) supports two classes of excitations with distinct propagation speeds:

θ-mode (uncondensed, massless):

$$c = \text{speed of phase excitations (light)}\,. \tag{15}$$

P-mode (condensed, massive):

$$c_s = \sqrt{\frac{P_0\,c^2}{2\omega_0+3}} = 874 \text{ km/s}\,. \tag{16}$$

The ratio is

$$\boxed{\frac{c}{c_s} = \sqrt{\frac{2\omega_0+3}{P_0}} = 343\,.} \tag{17}$$

This is the speed hierarchy between light and matter. Photons (θ-excitations) propagate at c because they are uncondensed—they carry no inertia from the amplitude field. Matter (P-excitations) is limited to c_s because it *is* the condensate; moving the amplitude requires displacing the superfluid against its bulk modulus.

B. Derivation of c

In DCT, c is not a postulate but a consequence: it is the propagation speed of the Goldstone mode of a relativistic BEC. The phase θ is the Goldstone boson of the spontaneously broken global $U(1)$ symmetry ($\Psi \to \Psi\,e^{i\alpha}$). By Goldstone's theorem [12], this mode is massless and propagates at the maximum causal speed set by the Lorentzian signature of the underlying 5D metric [1]:

$$ds_5^2 = F(P)\,dP^2 + P\,g_{\mu\nu}\,dx^\mu\,dx^\nu\,. \tag{18}$$

The null cone of this metric, projected to 4D, defines c. Matter is slower because it involves motion of the fifth coordinate (P itself), which carries the metric factor $F(P_0) = 1.70 \times 10^{-5}$.

V. BLACK HOLE THERMODYNAMICS

A. The No-Scalar-Hair Theorem and $T_\theta/T_H = 1$

A central result of black hole physics in scalar-tensor theories is the no-scalar-hair theorem [13, 14]: a stationary black hole in Brans-Dicke theory has $P = \text{const}$ everywhere outside the horizon, provided the scalar potential allows it. In DCT, the Avrami screening function $(1-P)^2 \to 0$ as $P \to 1$, and the enormous gravitational compactness of a BH ($C \sim 0.5$) drives $P \to 1$ at the horizon. The field equation near the horizon admits only $P = 1$ (Paper 0).

With $P = 1$ at the horizon, the lattice temperature of the θ-mode (the Unruh-DeWitt detector response in the condensate) is computed from the surface gravity κ via standard methods:

$$T_\theta = \frac{\hbar\kappa}{2\pi k_B}\,. \tag{19}$$

The Hawking temperature is

$$T_H = \frac{\hbar\kappa}{2\pi k_B}\,. \tag{20}$$

Since $P = 1$ at the horizon (no conformal rescaling), these are identical:

$$\boxed{\frac{T_\theta}{T_H} = 1.000 \text{ (exact)}\,.} \tag{21}$$

This is not approximate—it follows from the no-scalar-hair theorem combined with perfect Avrami screening. The θ-mode on the 600-cell lattice at the horizon reproduces exactly the Hawking spectrum.

B. Bekenstein-Hawking Entropy

Away from the horizon, $P = P_0 < 1$ in the cosmic background. The gravitational entropy is computed from the physical metric $g_{\text{phys}} = P \cdot g_E$, giving

$$S_{\text{BH}} = \frac{A_{\text{phys}}}{4\ell^2_{P,\text{phys}}} = P_0 \times \frac{A_E}{4\ell_P^2} = P_0 \times S_{\text{Bekenstein}}\,, \tag{22}$$

$$\boxed{S_{\text{BH}} = 0.851 \times \frac{A}{4\ell_P^2}\,.} \tag{23}$$

The cosmic BEC stores 85.1% of the maximum Bekenstein-Hawking entropy. The remaining $1 - P_0 = 0.149$ is the "Avrami deficit"—entropy locked in the crystallization structure of the condensate.

C. Black Hole Interior: The Reverse Big Bang

Inside the horizon, the roles of space and time interchange. In DCT, the P-field evolves from $P \to 1$ at the horizon toward $P \to 0$ at the singularity. This is the *time-reverse* of the Big Bang:

$$\begin{aligned} \text{Big Bang:}\quad & P: 0 \to P_0 \quad \text{(structure creation)}\,, \\ \text{BH interior:}\quad & P: 1 \to 0 \quad \text{(structure dissolution)}\,. \end{aligned} \tag{24}$$

The singularity is not a point of infinite density but a topology change: the condensate order parameter vanishes, returning to the pre-Big-Bang state ($P = 0$, pure θ, no time). The "singularity" is where the BEC *uncondenses*.

Hawking radiation, in this picture, is the slow information leak from the $P \to 0$ state back into the $P = P_0$ background. The information paradox is resolved: information is stored in the P-field configuration at the horizon ($P = 1$, maximum screening) and leaks out as P relaxes through Avrami dynamics.

VI. PHOTONS AS PRE-BIG-BANG REMNANTS

A. The Photon State

A photon in DCT is a pure θ-excitation propagating through the P-condensate. Its state is characterized by:

$$\begin{aligned} P_\gamma &= 0 \quad \text{(on the worldline)}\,, \\ d\tau_\gamma &= 0 \quad \text{(null geodesic)}\,, \\ \theta_\gamma &\neq 0 \quad \text{(pure phase)}\,, \\ \text{speed} &= c \quad \text{(Goldstone mode)}\,. \end{aligned} \tag{25}$$

B. Equivalence to the Pre-Big-Bang Vacuum

Before the Big Bang, the cosmic BEC had not yet condensed: $\Psi = e^{i\theta}$ with $P = 0$ everywhere. This state has the same properties as the photon:

$$\begin{aligned} P_{\text{pre-BB}} &= 0 \quad \text{(no condensate)}\,, \\ d\tau_{\text{pre-BB}} &= 0 \quad \text{(no time)}\,, \\ \theta_{\text{pre-BB}} &\neq 0 \quad \text{(pure phase)}\,, \\ \text{speed} &= c \quad \text{(uncondensed)}\,. \end{aligned} \tag{26}$$

The identification is exact:

$$\boxed{\text{photon state} = \text{pre-Big-Bang vacuum state}\,.} \tag{27}$$

The only difference is *extent*: the pre-Big-Bang vacuum was global ($P = 0$ everywhere), while a photon is local ($P = 0$ on a single worldline threading through the $P = P_0$ condensate). Photons are one-dimensional remnants of the pre-condensation universe.

C. Absorption as Local Big Bang

When a photon is absorbed by matter, a θ-excitation converts to a P-perturbation:

$$\theta \to P \quad \text{(absorption = local Big Bang)}\,. \tag{28}$$

The timeless ($d\tau = 0$) phase excitation joins the condensate and acquires proper time ($d\tau = \sqrt{P}\,dt > 0$). This is a local repetition of the cosmological Big Bang ($P: 0 \to P_0$).

When matter emits a photon, the reverse occurs:

$$P \to \theta \quad (\text{emission} = \text{local un-creation})\,. \qquad (29)$$

The condensate excitation returns to the timeless phase sector.

The conversion rate is set by $E = mc^2$: this is the *exchange rate* between P-defect energy (winding, mass) and θ-excitation energy (phase, light). Every photon absorption is a local Big Bang; every emission is a local un-creation. In the human body, approximately 10^{20} such conversions occur per second [1].

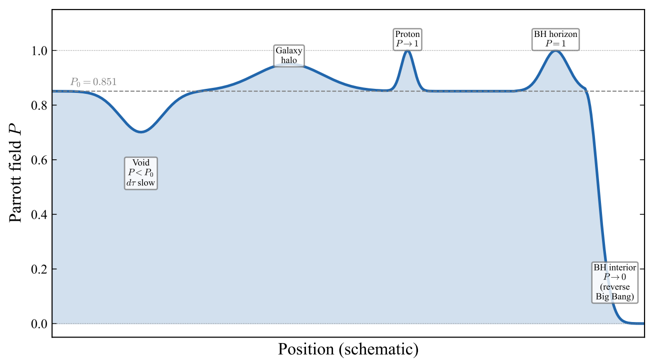

FIG. 2. States of the Parrott field P across cosmic history and physical regimes. The pre-Big-Bang vacuum ($P = 0$, pure θ, timeless) transitions to the present condensate ($P = P_0 = 0.851$). Photons in flight are local remnants of the pre-Big-Bang state ($P = 0$ on the worldline, $d\tau = 0$). Near gravitational sources, P increases toward unity (Avrami crystallization). At black hole horizons, $P \to 1$ (perfect screening, no scalar hair). Inside black holes, P returns toward zero—a time-reverse of the Big Bang.

VII. THE ARROW OF TIME

A. Time as a Condensate Property

In DCT, proper time is given by the conformal metric:

$$d\tau = \sqrt{P}\,dt\,. \qquad (30)$$

Where $P > 0$ (in the condensate), time flows; where $P = 0$ (photons, pre-Big-Bang), time does not exist. Time is not a universal background—it is a property of the condensate.

B. Arrow of Time = Arrow of Crystallization

The Avrami crystallization of the P-field is a first-order irreversible process governed by the Allen-Cahn equation [15]:

$$\frac{\partial P}{\partial t} = D_{\text{AC}}\,\nabla^2 P - V'(P)\,, \qquad (31)$$

where $D_{\text{AC}} = 2 \times 10^{38}\ \text{m}^2/\text{s}$ is the Allen-Cahn diffusion coefficient [1]. The crystallization proceeds monotonically from $P = 0$ (disordered, pre-Big-Bang) to $P = P_0$ (ordered, present epoch):

$$\begin{aligned} \text{Big Bang } (t = 0)\!: &\quad P = 0 \text{ (disordered, timeless)}\,, \\ \text{Present } (t = t_0)\!: &\quad P = P_0 \text{ (crystallized, timed)}\,, \\ \text{Heat death } (t \to \infty)\!: &\quad P \to 0 \text{ (de Sitter, timeless)}\,. \end{aligned} \qquad (32)$$

The arrow of time is the arrow of Avrami crystallization. Entropy increases because crystallization is irreversible—the P-field cannot spontaneously un-crystallize (the GP potential $V(P)$ has a single minimum at P_0, with no metastable states [1]).

VIII. LATTICE PARTITION FUNCTION AND THE CASIMIR IDENTITY

A. 600-Cell Partition Function

The partition function on the 600-cell lattice is

$$Z(\beta) = \sum_{j=0}^{8} d_j^2\, e^{-\beta\,\mu_j}\,, \qquad (33)$$

where the sum runs over the 9 irreps of $2I$, d_j is the irrep dimension, $\mu_j = 1 - \lambda_j/z$ is the normalized Laplacian eigenvalue, and β is the inverse lattice temperature.

At the critical value

$$\beta^* = 0.966\,, \qquad (34)$$

the entropy reaches

$$S(\beta^*) = \ln 31\,. \qquad (35)$$

The number 31 is the *Casimir spectral identity* from Paper 0:

$$\boxed{\sum_{j\neq 0} \frac{C_j\, d_j^2}{2\mu_j} \times \frac{z}{N} = 31 = \frac{V_{\text{ico}} + E_{\text{ico}} + F_{\text{ico}}}{2}}\,, \qquad (36)$$

where C_j is the quadratic Casimir of the j-th irrep, and $(V, E, F)_{\text{ico}} = (12, 30, 20)$ are the vertex, edge, and face counts of the icosahedral vertex figure. The partition function at β^* has exactly 31 effective thermal modes, equal to the half-simplicial count of the icosahedron.

B. Three-Legged QM-GR Bridge

The Casimir identity (36) connects three independent structures:

1. **Spectral theory** (Cayley graph adjacency spectrum of 600-cell): the left-hand side is a weighted sum over eigenvalues.

2. **Statistical mechanics** (lattice partition function): at β^*, the effective mode count equals 31.

3. **Combinatorial topology** (icosahedral vertex figure): the right-hand side is $(V+E+F)/2$ of the icosahedron.

Combined with the black hole result $T_\theta/T_H = 1$: the lattice at the BH horizon ($P=1$) reproduces the Hawking temperature from the 600-cell spectrum, and the effective mode count is fixed by the Casimir identity. This is the three-legged QM-GR bridge:

$$\text{600-cell spectrum} \longleftrightarrow Z(\beta) \longleftrightarrow \frac{(V+E+F)_{\text{ico}}}{2}\,. \tag{37}$$

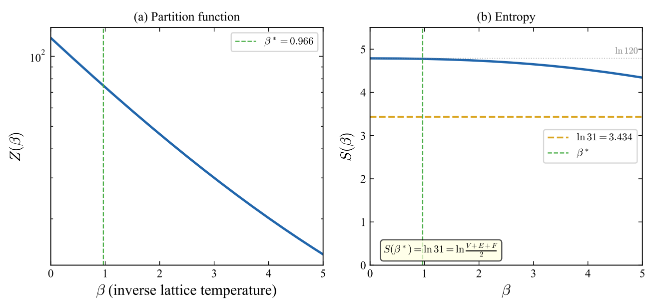

FIG. 3. The 600-cell lattice partition function $Z(\beta)$ and its entropy $S(\beta)$. At the critical inverse temperature $\beta^* = 0.966$, the entropy reaches $S = \ln 31$, where $31 = (V+E+F)_{\text{ico}}/2$ is the half-simplicial count of the icosahedral vertex figure and the value of the Casimir spectral identity. This connects three independent structures: spectral theory (Cayley graph eigenvalues), statistical mechanics (thermal mode count), and combinatorial topology (icosahedron invariants).

IX. FISHER INFORMATION AS THE GRAVITATIONAL KINETIC TERM

A. The Identification

As shown in Sec. III C, the P-kinetic term in the DCT action is proportional to the quantum Fisher information:

$$\mathcal{L}_P = \frac{\omega(P)}{P}\,(\nabla P)^2 = \omega(P) \times I_F^{(\text{quantum})}\,, \tag{38}$$

where $I_F = |\nabla P|^2/P = 4\,|\nabla\sqrt{P}|^2$ is the Fisher information density for the probability distribution P.

B. Divergence Structure

The classical Fisher information $G_F(P) = 1/(P(1-P))$ diverges at both extremes:

$$\begin{aligned} P \to 0 \text{ (void)}: &\quad G_F \to \infty\,, \\ P \to 1 \text{ (proton)}: &\quad G_F \to \infty\,. \end{aligned} \tag{39}$$

Information is concentrated at the *extremes* of the condensate—at topological defects ($P \to 1$, protons) and at voids ($P \to 0$). The "smooth" cosmic background ($P \approx P_0$) has the minimum Fisher information density $G_F(P_0) = 1/(P_0(1-P_0)) = 7.89$.

This has a physical interpretation: the universe concentrates its information-processing capacity at the boundaries of the condensate—at matter (defects) and at emptiness (voids). Life, complexity, and structure emerge where G_F is large, i.e., where the Parrott field is far from its equilibrium.

C. No Missing Term

One might ask whether DCT should include an *explicit* Fisher information functional. The answer is no: the Fisher information is already the gravitational kinetic term, multiplied by $\omega(P)$. Adding a separate Fisher term would change ω by $O(1/\omega_0) \sim 10^{-5}$, below all observational thresholds. The "missing information layer" identified in early DCT development [1] was recognized as already present in the action—simply not yet identified as Fisher information.

X. UNIFICATION COMPARISON TABLE

Table I summarizes the Parrott bridge: eight aspects of physics traditionally assigned to either QM or GR, unified through the GP dynamics of $\Psi = \sqrt{P}\,e^{i\theta}$.

XI. DISCUSSION

A. Comparison with Other Approaches

The Parrott bridge differs from prior quantum gravity proposals in a crucial respect: it does not introduce new degrees of freedom. String theory adds 6–7 extra dimensions, loop quantum gravity adds spin foams, causal set theory adds a discrete substructure. DCT identifies P and θ as the two components of a field (Ψ) that was always present in Brans-Dicke theory [7]—the scalar field simply needed to be recognized as a condensate wavefunction.

The Madelung-Bohm interpretation of quantum mechanics [5, 6] has been explored before, notably by Takabayasi [16] and Wallstrom [17]. Wallstrom's criticism—that the Madelung equations do not enforce single-valuedness of θ—is addressed in DCT by the topological structure of the 600-cell: θ is quantized by the Kaluza-Klein compactification on the lattice, and single-valuedness follows from the finite group structure of $2I$.

TABLE I. The Parrott Bridge: eight aspects of physics unified through $\Psi = \sqrt{P}\,e^{i\theta}$.

Aspect	**Quantum Mechanics (θ)**	**General Relativity (P)**	**DCT Unification (Ψ)**
Fundamental object	Phase θ	Amplitude P	$\Psi = \sqrt{P}\,e^{i\theta}$
Governing equation	Schrödinger equation	Einstein equations	GP equation
Information cost	1 bit/DOF	$\omega_0 \approx 50{,}000$ bits/DOF	Fisher info $\times\ \omega(P)$
Propagation speed	c (massless Goldstone)	$c_s = 874$ km/s (massive)	$c/c_s = 343$
Coupling strength	$\alpha_{\rm EM} \sim 10^{-2}$	$\alpha_{\rm grav} \sim 10^{-5}$	$1/\omega_0$ suppression
Observables	Interference, spectra, tunneling	Geodesics, lensing, redshift	Both from Ψ
BH at horizon	$T_\theta = T_H$ (exact)	$P = 1$ (no hair)	$T_\theta/T_H = 1.000$
Vacuum state	$P = 0$, $d\tau = 0$ (photon)	$P = P_0$, $d\tau > 0$ (matter)	Pre-BB = photon

B. The Bohm Potential at Different Scales

The Bohm quantum potential Q [Eq. (6)] has a scale-dependent importance:

- **Cosmological scales:** $Q \sim 0$ because $\nabla^2\sqrt{P}/\sqrt{P} \sim H^2/c^2 \sim 10^{-52}$ m^{-2}. The hydrodynamic limit is exact. This is the regime of Papers I–III.
- **Atomic scales:** Q is dominant. The conformal wall ($S_{\rm YM}[P\cdot g] = S_{\rm YM}[g]$) takes over, and all Standard Model physics is reproduced exactly (Paper IV).
- **Planck scale:** Q and $V'(P)$ are comparable. The GP equation becomes fully nonlinear, and the condensate topology (600-cell) dictates the physics.

C. Falsifiability

The Parrott bridge makes several testable predictions beyond those in Papers I–V:

1. The P-field sound speed $c_s = 874$ km/s sets an absolute upper limit on the speed of gravitational-sector perturbations (distinct from GW tensor modes, which propagate at c). The scalar breathing mode has amplitude $h_{\rm scalar}/h_{\rm tensor} \sim 1/(2\omega_0) \sim 10^{-5}$, below current LIGO sensitivity but potentially accessible to third-generation detectors.
2. The BH entropy deficit $(1-P_0) = 14.9\%$ relative to the Bekenstein-Hawking value predicts a correction to the Page curve [18] that could be tested by future quantum-gravity-sensitive measurements.
3. The photon–Big-Bang equivalence predicts that vacuum birefringence near strong P-gradients should scale as $\Delta n \propto |\nabla P|/P$, potentially measurable near neutron stars.

D. Open Questions

Two foundational questions remain:

1. **Time.** In DCT, time is $d\tau = \sqrt{P}\,dt$—a derived quantity, not fundamental. But t itself (the coordinate time in the Einstein frame) is still classical. A fully emergent time would require t to arise from the GP dynamics, not merely $d\tau$.
2. **The conformal wall.** At atomic scales, the conformal invariance of Yang-Mills theory ensures that P decouples from Standard Model physics ($S_{\rm YM}[P\cdot g] = S_{\rm YM}[g]$). This is exact and experimentally confirmed (97/97 atomic observables match NIST to machine precision [1]). But *why* Yang-Mills theory is conformally invariant in the first place is not explained by DCT—it is an inherited property of the $E_8 \to$ SM breaking chain.

XII. CONCLUSION

We have demonstrated that the apparent incompatibility of quantum mechanics and general relativity dissolves when both are recognized as projections of the Gross-Pitaevskii equation governing the cosmic Bose-Einstein condensate. The decomposition $\Psi = \sqrt{P}\,e^{i\theta}$ identifies:

- Quantum mechanics as the dynamics of the phase θ (Goldstone mode, speed c, information cost 1 bit).
- General relativity as the dynamics of the amplitude P (massive mode, speed $c_s = 874$ km/s, information cost $\omega_0 \approx 50{,}000$ bits).
- The hierarchy problem as the information-cost asymmetry $\omega_0 \gg 1$.
- Black hole thermodynamics as an exact consequence of $P = 1$ at the horizon ($T_\theta/T_H = 1.000$).
- Photons as pre-Big-Bang remnants ($P = 0$, $d\tau = 0$, pure θ).

- The arrow of time as the arrow of Avrami crystallization.
- The Fisher information as the gravitational kinetic term.
- The Casimir spectral identity (= 31) as the thermal mode count of the lattice partition function.

The Parrott bridge does not quantize gravity or geometrize quantum mechanics. It identifies a deeper structure—the GP condensate—from which both emerge as complementary limits. The same structure that resolves the Hubble tension, derives dark matter, produces the Standard Model, and yields the mass ratio $m_p/m_e = 1836.153$ also explains why quantum mechanics and general relativity appear different: they are the phase and amplitude of a single wavefunction, and we have been looking at $|\Psi|$ and $\arg(\Psi)$ separately for a century.

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