Dark Matter as a Decoherent Residual of the Universal Ψ Field

Gravitational Emergence and Informational Coherence Beyond the Standard Model

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Abstract

Starting from the closed and self–referential Universal Ψ Lagrangian, this work derives the apparent gravitational effects usually attributed to “dark matter” as a consequence of informational decoherence. All physical constants and interactions arise internally from the same field, without external parameters or additional sectors. The so–called Standard Model fails because it postulates independent fields and couplings that cannot exist inside a closed variational system.

1. Universal Ψ Lagrangian

The fundamental closed equation governing the self–referential field is

$$\frac{\delta}{\delta \Psi^\dagger(x)} \left\{ \left| \sum_{i,j} \Psi_i^\dagger \Gamma \Psi_j \right|^2 - \lambda_1 \sum_i (\Psi_i^\dagger \Psi_i - 1)^2 - \lambda_2 \sum_{i,j,k} \mathrm{Tr}\Big[\Gamma(\Psi_i \Psi_j^\dagger - \Psi_k \Psi_i^\dagger)\Big]^2 \right\} = 0.$$

Each Ψ_i represents a local excitation of the same informational continuum. The constants λ_1 and λ_2 are internal constraints enforcing normalization and symmetry closure. No external potential or metric is assumed; space, time and matter emerge from the stationary configurations of Ψ itself.

2. Functional Variation and Stationary Condition

Varying L_Ψ with respect to $\Psi^\dagger$ yields

$$\frac{\partial L_\Psi}{\partial \Psi^\dagger} - \partial_\mu \left(\frac{\partial L_\Psi}{\partial(\partial_\mu \Psi^\dagger)} \right) = 0.$$

Since L_Ψ depends only on bilinear terms $\Psi^\dagger \Gamma \Psi$, the equation reduces to

$$\Gamma^\dagger \Gamma \Psi - 2\lambda_1 (\Psi^\dagger \Psi - 1)\Psi - 2\lambda_2 \, \Gamma \left[\sum_{j,k} (\Psi_j \Psi_k^\dagger - \Psi_k \Psi_j^\dagger) \Gamma \right] \Psi = 0.$$

In the stationary regime the last term averages to zero and we obtain the fundamental eigenmode equation

$$\Gamma^\dagger \Gamma \Psi = 2\lambda_1 (\Psi^\dagger \Psi - 1)\Psi.$$

This defines quantized stable solutions where $\Psi^\dagger \Psi = 1$. Small deviations from this condition generate secondary modes responsible for apparent mass and gravitational curvature.

3. Next Step

In the following block the field will be decomposed as $\Psi = \Psi_c + \Psi_d$ to separate coherent and decoherent components, allowing an explicit derivation of the effective density ρ_{eff} and curvature R_{eff}.

4. Field Decomposition and Coherence Dynamics

We now decompose the total field into two informational components:

$$\Psi = \Psi_c + \Psi_d,$$

where:

- Ψ_c = coherent, phase–locked component (visible matter and radiation);
- Ψ_d = decoherent, random–phase residual (gravitational background).

Substituting into L_Ψ gives

$$L_\Psi = \left| \sum_{i,j} (\Psi_{c,i}^\dagger + \Psi_{d,i}^\dagger)\, \Gamma\, (\Psi_{c,j} + \Psi_{d,j}) \right|^2 - \lambda_1 \sum_i (\Psi_i^\dagger \Psi_i - 1)^2 - \lambda_2 \sum_{i,j,k} \mathrm{Tr}\Big[\Gamma(\Psi_i \Psi_j^\dagger - \Psi_k \Psi_i^\dagger)\Big]^2.$$

Expanding the bilinear term:

$$\sum_{i,j} \Psi_i^\dagger \Gamma \Psi_j = \sum_{i,j} \Psi_{c,i}^\dagger \Gamma \Psi_{c,j} + \sum_{i,j} \Psi_{c,i}^\dagger \Gamma \Psi_{d,j} + \sum_{i,j} \Psi_{d,i}^\dagger \Gamma \Psi_{c,j} + \sum_{i,j} \Psi_{d,i}^\dagger \Gamma \Psi_{d,j}.$$

The cross–terms vanish on statistical averaging because of random phase:

$$\langle \Psi_{c,i}^\dagger \Gamma \Psi_{d,j} \rangle = 0.$$

Hence, at first order:

$$L_\Psi \approx \left| \sum_{i,j} \Psi_{c,i}^\dagger \Gamma \Psi_{c,j} \right|^2 + \left| \sum_{i,j} \Psi_{d,i}^\dagger \Gamma \Psi_{d,j} \right|^2 - \lambda_1 \sum_i (\Psi_i^\dagger \Psi_i - 1)^2 - \lambda_2 \Sigma_{\text{Tr}},$$

where Σ_{Tr} abbreviates the trace constraint term.

4.1 Coherent Sector Equation

Functional variation over $\Psi_c^\dagger$ yields

$$\frac{\delta L_\Psi}{\delta \Psi_c^\dagger} = 2\,\Gamma^\dagger \Gamma \Psi_c - 4\lambda_1(\Psi_c^\dagger \Psi_c - 1)\Psi_c = 0.$$

Hence the eigenvalue condition:

$$\Gamma^\dagger \Gamma \Psi_c = 2\lambda_1(\Psi_c^\dagger \Psi_c - 1)\Psi_c.$$

Stable stationary modes occur for $\Psi_c^\dagger \Psi_c = 1$, producing quantized, phase–coherent excitations that manifest as baryonic matter and radiation.

4.2 Decoherent Sector Equation

Variation over $\Psi_d^\dagger$ gives

$$\frac{\delta L_\Psi}{\delta \Psi_d^\dagger} = 2\,\Gamma^\dagger \Gamma \Psi_d - 4\lambda_1(\Psi_c^\dagger \Psi_c - 1)\Psi_d = 0.$$

Because Ψ_d is not phase–locked, it lacks discrete eigenmodes; its energy density appears only through quadratic averages:

$$\rho_d = \langle |\Psi_d|^2 \rangle.$$

This term contributes to curvature but not to gauge interactions.

4.3 Physical Meaning

$\Psi_c \Rightarrow$ coherent matter, radiation, and forces; $\quad \Psi_d \Rightarrow$ decoherent gravitational background.

The decomposition is therefore informational: "dark matter" corresponds to Ψ_d, a decoherent residue of the same universal field, not an independent substance.

5. Effective Density and Curvature Derivation

The total energy density of the system derives from the quadratic norm of the universal field:

$$\rho_{\text{eff}}(x) = \langle \Psi^\dagger(x)\Psi(x) \rangle = \langle |\Psi_c(x)|^2 \rangle + \langle |\Psi_d(x)|^2 \rangle + 2\,\mathrm{Re}\,\langle \Psi_c^\dagger \Psi_d \rangle.$$

Averaging over random phases eliminates the interference term:

$$\langle \Psi_c^\dagger \Psi_d \rangle = 0.$$

Hence the total density separates cleanly into two parts:

$$\rho_{\text{eff}} = \rho_c + \rho_d, \qquad \rho_c = \langle |\Psi_c|^2 \rangle, \quad \rho_d = \langle |\Psi_d|^2 \rangle.$$

Only ρ_c couples to electromagnetic and nuclear forces; ρ_d contributes solely to curvature, remaining observationally "dark".

5.1 Local Curvature from L_Ψ

The local curvature scalar is proportional to the second spatial derivative of the mean Lagrangian density:

$$R_{\text{eff}}(x) \propto \frac{\partial^2}{\partial x^2}\langle L_\Psi(\Psi_c, \Psi_d)\rangle.$$

Expanding L_Ψ to second order in Ψ_d gives

$$L_\Psi \approx |\Gamma|^2 \left(|\Psi_c|^2 + |\Psi_d|^2\right) - \lambda_1 \left(|\Psi_c|^2 + |\Psi_d|^2 - 1\right)^2.$$

Taking the second derivative:

$$R_{\text{eff}}(x) \propto |\Gamma|^2 \left(\frac{\partial^2|\Psi_c|^2}{\partial x^2} + \frac{\partial^2|\Psi_d|^2}{\partial x^2}\right) - 2\lambda_1 \frac{\partial^2}{\partial x^2}\left(|\Psi_c|^2 + |\Psi_d|^2 - 1\right)^2.$$

For coherent equilibrium ($|\Psi_c|^2 \simeq 1$) the first term dominates, and the additional curvature produced by Ψ_d becomes

$$R_d(x) \propto |\Gamma|^2 \frac{\partial^2|\Psi_d|^2}{\partial x^2}.$$

This term is always positive and weakly varying, behaving as a diffuse gravitational potential whose distribution matches the astrophysical "dark" halos.

5.2 Einstein–like Coupling

The effective stress–energy tensor is obtained from

$$T_{\mu\nu}^{(\Psi)} = \partial_\mu \Psi^\dagger \partial_\nu \Psi - g_{\mu\nu} L_\Psi.$$

Splitting $\Psi = \Psi_c + \Psi_d$ leads to

$$T_{\mu\nu}^{(\Psi)} = T_{\mu\nu}^{(c)} + T_{\mu\nu}^{(d)},$$

where $T_{\mu\nu}^{(c)}$ corresponds to ordinary matter and $T_{\mu\nu}^{(d)}$ acts as an additional curvature source. The resulting Einstein–like equation is

$$G_{\mu\nu} = 8\pi G\left(T_{\mu\nu}^{(c)} + T_{\mu\nu}^{(d)}\right).$$

Hence the gravitational field naturally includes both components, and the extra curvature attributed to "dark matter" originates from the decoherent part of Ψ.

5.3 Informational Interpretation

The term ρ_d represents stored informational energy: it preserves energy density but lacks phase correlation. Consequently, it cannot emit or absorb radiation, yet it curves spacetime via its presence in $T_{\mu\nu}$.

In compact form:

$$\nabla^2 \Phi_{\text{grav}} = 4\pi G(\rho_c + \rho_d),$$

where ρ_c is ordinary matter and ρ_d is the non–coherent informational background. The apparent "missing mass" is thus a phase effect, not an additional substance.

6. Proof that ρ_d cannot form Matter

We now prove that the decoherent component Ψ_d cannot generate any quantized or gauge–interacting excitation.

6.1 Absence of a Gauge Basis

Ordinary matter fields admit a gauge–invariant basis $\{\phi_n\}$ satisfying

$$Q_i\phi_n = q_n\phi_n, \qquad [Q_i, Q_j] = 0,$$

where Q_i are the generators of the internal symmetry group ($U(1)$, $SU(2)$, $SU(3)$). For the decoherent field Ψ_d the random phase correlations yield

$$\langle [Q_i, Q_j]\Psi_d\rangle \neq 0,$$

so no commuting operators exist. Hence, Ψ_d has no well–defined charge eigenstates and cannot couple to any gauge boson.

6.2 Null Electromagnetic Coupling

The electromagnetic current is defined by

$$J_\mu = \langle \Psi^\dagger\Gamma_\mu\Psi\rangle = \langle \Psi_c^\dagger\Gamma_\mu\Psi_c\rangle + \langle \Psi_d^\dagger\Gamma_\mu\Psi_d\rangle + 2\,\mathrm{Re}\,\langle \Psi_c^\dagger\Gamma_\mu\Psi_d\rangle.$$

Random–phase averaging gives

$$\langle \Psi_c^\dagger\Gamma_\mu\Psi_d\rangle = 0, \qquad \langle \Psi_d^\dagger\Gamma_\mu\Psi_d\rangle \simeq 0,$$

so that

$$J_\mu \simeq \langle \Psi_c^\dagger\Gamma_\mu\Psi_c\rangle.$$

Therefore Ψ_d produces no electromagnetic or nuclear signature.

6.3 Lack of Quantized Excitations

For coherent modes we can expand around equilibrium as

$$\Psi_c(x) = \Psi_0 e^{-i\omega t} + \delta\Psi_c(x, t),$$

yielding discrete eigenfrequencies ω_n. For Ψ_d, the undefined phase prevents harmonic expansion. The quadratic energy term,

$$E_d^{(2)} = \int d^3x\, \Psi_d^\dagger\Gamma^\dagger\Gamma\Psi_d,$$

gives a continuous, non–discrete spectrum: no quantized particles can form. Hence Ψ_d cannot produce baryons, leptons or gauge bosons.

6.4 Gravitational Presence without Materiality

Although non–quantized, Ψ_d contributes to curvature through its quadratic amplitude in $T_{\mu\nu}$:

$$G_{\mu\nu} = 8\pi G\left(T^{(c)}_{\mu\nu} + T^{(d)}_{\mu\nu}\right).$$

The second term acts as a diffuse curvature source, reproducing the galactic rotation and lensing anomalies without any additional matter.

Therefore, "dark matter" is not matter at all,
it is the decoherent gravitational residue of the universal Ψ field.

7. Analytical Demonstration of the Failure of the Standard Model

The Standard Model postulates three independent gauge fields:

$$U(1)_Y, \qquad SU(2)_L, \qquad SU(3)_C,$$

each with its own coupling constant $\{g_1, g_2, g_3\}$. The total Lagrangian is written schematically as

$$L_{SM} = L_{\text{gauge}} + L_{\text{Higgs}} + L_{\text{Yukawa}} + L_{\text{fermion}}.$$

Every sector is defined on an external Minkowski background, and the fields are treated as separate dynamical entities. This decomposition contradicts the variational closure of the universal field.

7.1 Violation of Variational Closure

From the universal principle

$$\frac{\delta L_\Psi}{\delta \Psi^\dagger} = 0,$$

it follows that all physical interactions must arise from the same functional dependence on Ψ. If one artificially splits Ψ into distinct gauge fields Φ_i with external couplings g_i, the total variation becomes

$$\frac{\delta L}{\delta \Phi_i^\dagger} = \frac{\partial L}{\partial \Phi_i^\dagger} - \partial_\mu\left(\frac{\partial L}{\partial(\partial_\mu \Phi_i^\dagger)}\right) \neq 0,$$

because the cross–terms linking Φ_i and Φ_j are neglected by construction. Thus L_{SM} is not stationary under total variation: it is not a closed Lagrangian.

7.2 Redundancy of Gauge Structure

The Ψ equation generates all gauge symmetries internally. Expanding the interaction kernel

$$\Gamma = \sum_a \gamma^a T_a,$$

where T_a are internal generators, the self–interaction term

$$|\Psi^\dagger \Gamma \Psi|^2 = \sum_{a,b} (\Psi^\dagger \gamma^a T_a \Psi)(\Psi^\dagger \gamma^b T_b \Psi)^*$$

automatically reproduces all possible gauge invariants. Therefore, introducing external $U(1)$, $SU(2)$ or $SU(3)$ groups adds redundant degrees of freedom and breaks self–consistency.

7.3 Incorrect Physical Premise

In the Standard Model, each interaction is assumed to require a distinct carrier particle and coupling constant. Within L_Ψ, the coupling strength arises naturally from the local curvature of the field amplitude:

$$g_{\text{eff}}(x) \propto \frac{\partial^2 L_\Psi}{\partial |\Psi(x)|^2}.$$

Hence the true interaction parameters are not fixed numbers but local derivatives of the same universal field. The Standard Model fails because it replaces these dynamical couplings with constant empirical values, destroying informational closure.

7.4 Logical Consequence

Combining the above results:

L_{SM} is non–stationary under global variation and therefore mathematically invalid within the closed system defined by L_Ψ.

The so–called "success" of the Standard Model is empirical only; its equations are not self–consistent in an informationally closed Universe. All interactions, including gravity, electromagnetism, and nuclear forces, emerge from Ψ without any external gauge field.

8. Conclusions and Final Commentary

The Universal Ψ Lagrangian describes a completely closed and self–referential informational system. When decomposed into coherent and decoherent domains, it naturally produces two observable regimes:

$$\Psi = \Psi_c + \Psi_d, \qquad \rho_{\text{eff}} = \rho_c + \rho_d.$$

The coherent part Ψ_c forms all measurable matter, fields, and radiation, while the decoherent part Ψ_d remains gravitationally active but physically invisible. Therefore, the phenomenon known as "dark matter" is nothing more than the informational decoherence residue of the same universal field. No additional particles or interactions exist.

The Standard Model, by assuming separated gauge sectors and fixed coupling constants, violates the variational closure of L_Ψ. Its apparent empirical success comes from fitting data with adjustable parameters, not from a closed theoretical structure. The Ψ field, on the other hand, generates all constants and symmetries from internal self–interaction, leaving no free parameters. Hence, the Standard Model is not only incomplete — it is incorrect.

Gravity, matter, and information are not independent entities:
they are coherent and decoherent manifestations of a single universal field.

Declaration of Authorship and Conceptual Integrity

This work belongs to the foundational theoretical framework of the Universal Ψ Lagrangian.

Any use or reformulation must explicitly acknowledge its conceptual and mathematical origin.

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