Unified Carrier Wavefunction and the Standard Model

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Abstract

The Standard Model describes known particle interactions with extraordinary success, but its wavefunction forms are usually introduced as distinct mathematical species: scalar fields, vector fields, Dirac spinors, quark fields with color, and gluon fields with color. This paper proposes a lean interface between those forms and a unified carrier wavefunction. The carrier is a nine-component object with block structure $1+3+4+1$, selected by projectors P_0, P_V, P_D, and P_χ. Scalar, vector, Dirac, quark/color-spinor, and gluon/color-vector states are then treated as realized sectors of one carrier rather than unrelated wavefunction types. The construction does not replace the Standard Model. Electric charge remains assigned by $Q = T_3 + Y/2$, chirality remains a Dirac-sector projection, QCD supplies local color transport, electroweak theory resolves vector modes, and CKM/PMNS remain mixing interfaces. The main contribution is organizational: color is interpreted as an internal carrier orientation, quark and gluon color share the same color-extension sector, fractional quark charge magnitudes become structurally available in the color-active carrier sector, and weak decay is separated into mass reassignment, weak-branch reassignment, route weighting, admissibility, and amplitude layers. The result is a conservative embedding in which the carrier absorbs field-form bookkeeping while the Standard Model supplies physical dynamics.

Contents

1 Introduction

The Standard Model is one of the most successful frameworks in modern physics. Its field content, gauge symmetries, interaction structure, and scattering predictions have been tested with extraordinary precision [1, 2, 3]. The purpose of the present paper is not to replace that framework, nor to reconstruct the full Standard Model Lagrangian from a new starting point. The purpose is narrower: to identify the minimal touchpoints where the unified carrier wavefunction interfaces with the Standard Model.

The motivation is that the Standard Model uses several different visible wavefunction forms. Scalar particles are represented by scalar fields. Photons and weak vector bosons are represented by vector fields. Charged leptons are represented by Dirac spinors. Quarks require Dirac structure together with color. Gluons are vector gauge fields carrying color structure. These forms are all successful in their respective domains, but they are not normally presented as realized sectors of one common carrier.

The unified carrier wavefunction asks whether these field-form distinctions can be reorganized at the wavefunction level. The central object is the nine-component carrier

$$\Psi_U(x,t) = \begin{pmatrix} \phi(x,t) \\ A_x(x,t) \\ A_y(x,t) \\ A_z(x,t) \\ \psi_1(x,t) \\ \psi_2(x,t) \\ \psi_3(x,t) \\ \psi_4(x,t) \\ \chi_C(x,t) \end{pmatrix},$$

with block structure

$$1+3+4+1=9.$$

The first component is the scalar slot, the next three components form a minimal vector chart, the next four components form the Dirac spinor slot, and the final component is a color-extension slot. At the Standard Model interface, the usual covariant notation such as A_μ, W_μ^a, and G_μ^a is restored.

The corresponding primitive projectors are

$$P_0, \qquad P_V, \qquad P_D, \qquad P_\chi,$$

with

$$P_0 + P_V + P_D + P_\chi = I_9.$$

These projectors realize the familiar wavefunction forms as sectors of the same carrier:

$$P_0\Psi_U \to \text{scalar form},$$

$$P_V\Psi_U \to \text{vector form},$$

$$P_D\Psi_U \to \text{Dirac fermion form},$$

$$(P_D + P_\chi)\Psi_U \to \text{quark/color-spinor form},$$

and

$$(P_V + P_\chi)\Psi_U \to \text{gluon/color-vector form}.$$

This is the central carrier-level claim: scalar, vector, Dirac, quark/color-spinor, and gluon/color-vector wavefunction forms may be organized as realized sectors of one carrier rather than as unrelated wavefunction species [4].

This is a wavefunction-form statement, not a replacement of Standard Model dynamics. The carrier says what kind of wavefunction form has been realized. The Standard Model still supplies the physical charge assignments, gauge transport laws, chirality structure, mixing matrices, selection rules, and amplitudes. Electric charge remains governed by the electroweak charge operator

$$Q = T_3 + \frac{Y}{2},$$

chirality remains described by the standard projectors

$$P_L = \frac{1-\gamma^5}{2}, \qquad P_R = \frac{1+\gamma^5}{2},$$

and QCD color transport remains governed by the color-covariant derivative

$$D_\mu = \partial_\mu - ig_s G^a_\mu T^a.$$

The carrier therefore does not remove the Standard Model interface. It organizes the wavefunction forms on which that interface acts.

The guiding thesis of this paper is:

$$\boxed{\text{The carrier absorbs field-form bookkeeping; the Standard Model supplies charge, gauge dynamics, mixing weights}}$$

This thesis is intentionally conservative. It does not claim that the unified carrier replaces

$$SU(3)_C \times SU(2)_L \times U(1)_Y.$$

Instead, it treats the Standard Model gauge structure as the validated local transformation and dynamics layer, while the carrier supplies a common wavefunction realization grammar beneath the field forms.

The largest organizational shift occurs in the QCD sector. In ordinary notation, color appears as an index attached to quark and gluon fields. In the carrier picture, color becomes an internal color-extension orientation. Quarks are realized through

$$(P_D + P_\chi)\Psi_U,$$

while gluons are realized through

$$(P_V + P_\chi)\Psi_U.$$

Thus quark color and gluon color both involve the same carrier color-extension slot, while QCD continues to provide the local gauge transport and non-Abelian field dynamics. This does not eliminate QCD. It changes the interpretation of what the color labels are attached to [5, 6, 7].

A second important touchpoint is electric charge. The color-spinor construction can explain why fractional quark charge magnitudes such as 1/3 and 2/3 are structurally available in the color-active carrier sector. However, the physical assignment of electric charge remains the Standard Model assignment through

$$Q = T_3 + \frac{Y}{2}.$$

This distinction is essential. The color-spinor can provide a carrier-level reason why fractional quark magnitudes appear, while the Standard Model remains the rule by which physical electric charge is assigned and used [8, 9, 10, 1].

A third touchpoint concerns transformations. Not every physical process requires a change of carrier form. Some processes, such as photon-pair conversion into an electron–positron pair, involve a genuine carrier-form reassignment from vector-sector realizations into Dirac-sector realizations. Other processes, such as charged-lepton decay or quark charged-current decay, can preserve the broad carrier form while changing internal mass assignment, weak branch, or both. This motivates a separation between carrier-form transformations and internal process operations.

The paper therefore distinguishes the following roles. The carrier transformation T handles changes of realized wavefunction form. Internal operators $\mathcal{O}$ handle mass-tier, branch, or orientation changes inside an already-realized sector. Routing matrices R identify process channels. Admissibility factors $\mathcal{C}$ enforce conservation and selection rules. Amplitudes $\mathcal{A}$ remain supplied by the appropriate Standard Model or effective field-theory calculation. This separation prevents one operator from doing too many jobs [4].

The value of the unified carrier appears at three levels. First, it produces interpretive consequences for physical behaviour by changing the interpretation of color closure, gluon-mediated color reorientation, and weak decay as mass or branch reassignment. Second, it provides operator-level organization by separating carrier-form reassignment from internal process operations, routing, admissibility, and amplitudes. Third, it reduces representational complexity by placing scalar, vector, Dirac, quark/color-spinor, and gluon/color-vector forms inside one carrier grammar while preserving Standard Model dynamics.

The paper proceeds as follows. Section 2 defines the unified carrier as a wavefunction-form layer and displays the sector projectors. Section 3 states the Standard Model interface conditions that remain unchanged, including charge, chirality, helicity, electroweak vector mixing, QCD transport, CKM, and PMNS. Section 4 discusses interpretive consequences for physical behaviour, with emphasis on color closure, gluon reorientation, weak decay, and fractional charge availability. Section 5 organizes the transformation operators and separates T, $\mathcal{O}$, R, $\mathcal{C}$, and $\mathcal{A}$. Section 6 summarizes the structural streamlining and complexity reduction achieved by the carrier. Section 7 concludes.

2 The Unified Carrier and the Full Interface Map

The unified carrier is introduced as a wavefunction-form layer. Its purpose is not to replace the field equations of the Standard Model, but to provide a common carrier space in which the familiar visible wavefunction forms can be realized by projection. The carrier therefore answers the question of form: which kind of wavefunction has been realized? The Standard Model then answers the question of dynamics: how does that realized state transform, couple, propagate, and contribute to physical amplitudes?

Before introducing the detailed interface conditions, the full construction can be summarized in one map. The carrier is

$$\Psi_U(x,t) = \begin{pmatrix} \phi(x,t) \\ A_x(x,t) \\ A_y(x,t) \\ A_z(x,t) \\ \psi_1(x,t) \\ \psi_2(x,t) \\ \psi_3(x,t) \\ \psi_4(x,t) \\ \chi_C(x,t) \end{pmatrix}.$$

Its block structure is

$$1 + 3 + 4 + 1 = 9.$$

The first slot is scalar, the next three slots form a minimal vector chart, the next four slots form a Dirac spinor sector, and the final slot is a color-extension sector. The vector slot is displayed as a three-component carrier chart. At the Standard Model interface, the usual covariant notation A_μ, W^a_μ, and G^a_μ is restored.

The sectors are selected by

$$P_0, \qquad P_V, \qquad P_D, \qquad P_\chi,$$

with

$$P_0 + P_V + P_D + P_\chi = I_9.$$

The carrier realizations are

$$P_0\Psi_U \to \text{scalar form},$$

$$P_V\Psi_U \to \text{vector form},$$

$$P_D\Psi_U \to \text{Dirac fermion form},$$

$$(P_D + P_\chi)\Psi_U \to \text{quark/color-spinor form},$$

and

$$(P_V + P_\chi)\Psi_U \to \text{gluon/color-vector form}.$$

The Standard Model interface then attaches the physical structures:

$$Q = T_3 + \frac{Y}{2} \to \text{electric charge},$$

$$P_L = \frac{1-\gamma^5}{2}, \qquad P_R = \frac{1+\gamma^5}{2} \to \text{chirality},$$

$$D_\mu = \partial_\mu - ig_s G^a_\mu T^a \to \text{QCD color transport},$$

$$V_{\text{CKM}} \to \text{quark weak-route weights},$$

$$U_{\text{PMNS}} \to \text{neutrino mixing},$$

and

$$\mathcal{C}, \qquad \mathcal{A} \to \text{admissibility and amplitudes}.$$

Thus the carrier supplies the wavefunction-form layer, while the Standard Model supplies charge assignment, gauge dynamics, mixing, admissibility, and physical amplitudes.

The primitive projectors may now be displayed explicitly. The scalar projector is

$$P_0 = \mathrm{diag}(1, 0, 0, 0, 0, 0, 0, 0, 0),$$

so that

$$P_0\Psi_U = \begin{pmatrix} \phi \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}.$$

The vector projector is

$$P_V = \mathrm{diag}(0, 1, 1, 1, 0, 0, 0, 0, 0),$$

so that

$$P_V\Psi_U = \begin{pmatrix} 0 \\ A_x \\ A_y \\ A_z \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}.$$

The Dirac projector is

$$P_D = \mathrm{diag}(0,0,0,0,1,1,1,1,0),$$

so that

$$P_D\Psi_U = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ \psi_1 \\ \psi_2 \\ \psi_3 \\ \psi_4 \\ 0 \end{pmatrix}.$$

The color-extension projector is

$$P_\chi = \mathrm{diag}(0,0,0,0,0,0,0,0,1),$$

so that

$$P_\chi\Psi_U = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \chi_C \end{pmatrix}.$$

These projectors define the carrier-level field-form realizations. A scalar state is represented by

$$\Psi_{\text{scalar}} = P_0\Psi_U = \begin{pmatrix} \phi \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}.$$

A vector state is represented by

$$\Psi_{\text{vector}} = P_V\Psi_U = \begin{pmatrix} 0 \\ A_x \\ A_y \\ A_z \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}.$$

A Dirac fermion is represented by

$$\Psi_{\text{Dirac}} = P_D \Psi_U = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ \psi_1 \\ \psi_2 \\ \psi_3 \\ \psi_4 \\ 0 \end{pmatrix}.$$

A quark/color-spinor state is represented by the combined activation

$$\Psi_{\text{quark}} = (P_D + P_\chi) \Psi_U = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ \psi_1 \\ \psi_2 \\ \psi_3 \\ \psi_4 \\ \chi_C \end{pmatrix}.$$

A gluon/color-vector state is represented by

$$\Psi_{\text{gluon}} = (P_V + P_\chi) \Psi_U = \begin{pmatrix} 0 \\ A_x \\ A_y \\ A_z \\ 0 \\ 0 \\ 0 \\ 0 \\ \chi_C \end{pmatrix}.$$

This is the first major simplification supplied by the carrier. The usual field forms

scalar, vector, Dirac, quark/color-spinor, gluon/color-vector

are not treated as unrelated wavefunction species. They are treated as realized forms of one carrier [4].

The scalar realization

$$P_0 \Psi_U$$

corresponds to spin-0 scalar or Higgs-like field form. The carrier does not attempt in this step to derive the scalar potential or the Higgs mechanism. It only identifies the scalar wavefunction form.

The vector realization

$$P_V \Psi_U$$

corresponds to photon-like and weak-vector-boson-like field form. The carrier does not by itself decide whether the vector state is a photon, Z^0, or $W^\pm$. That distinction remains an electroweak interface question. The carrier supplies the vector wavefunction form; the Standard Model resolves the physical vector modes.

The Dirac realization

$$P_D \Psi_U$$

corresponds to ordinary spin-$\frac{1}{2}$ fermion form, such as charged leptons and neutrino-sector fermionic realizations. Chirality, mass, flavor, and weak coupling are not new carrier slots. They are interface or internal properties acting within, or on, the Dirac realization.

The quark realization

$$(P_D + P_\chi)\Psi_U$$

is the first place where the carrier does more than simply group already-known field forms. In ordinary notation, a quark is often described as a Dirac spinor with an additional color label. In the carrier picture, the color-active extension is part of the realized carrier form itself. The quark is therefore not written as a Dirac spinor plus a detached color tag, but as a color-spinor realization of the unified carrier [7].

The gluon realization

$$(P_V + P_\chi)\Psi_U$$

uses the same color-extension slot together with the vector sector. This means that quark color and gluon color are not introduced by two unrelated label systems. They both involve the same carrier color-extension sector, activated with different wavefunction-form sectors:

$$P_D + P_\chi \quad \text{for quark/color-spinor form,}$$

and

$$P_V + P_\chi \quad \text{for gluon/color-vector form.}$$

This does not replace QCD. Rather, it separates two questions that are often written together. The carrier describes what kind of color-active wavefunction form has been realized. QCD describes how that color-active form is locally transported and dynamically coupled. Thus the carrier reorganizes the wavefunction-form layer, while the gauge theory retains its standard role as the dynamics layer.

The same separation applies throughout the Standard Model interface. The carrier does not infer electric charge from mass. It does not replace chirality projectors. It does not replace electroweak mixing. It does not replace CKM or PMNS. It only provides the common carrier space in which the relevant wavefunction form is realized before those Standard Model structures act.

The resulting hierarchy is

$$\Psi_U \quad \longrightarrow \quad \text{carrier wavefunction,}$$

$$P_0,\ P_V,\ P_D,\ P_\chi \quad \longrightarrow \quad \text{field-form realization,}$$

$$Q,\ P_L,\ P_R,\ D_\mu,\ V_{\text{CKM}},\ U_{\text{PMNS}},\ \mathcal{C},\ \mathcal{A} \quad \longrightarrow \quad \text{Standard Model interface.}$$

In this hierarchy, the carrier is not a replacement for the interface. It is the object on which the interface acts.

This is the central reason for calling the construction a wavefunction-form layer. It compresses the field-form taxonomy into one realization grammar while preserving the Standard Model as the charge, gauge, mixing, admissibility, and amplitude layer.

3 The Standard Model Structures Left Intact

The unified carrier is useful only if it can be embedded into the Standard Model without disturbing the experimentally validated structures already in place. For this reason, the present section states the interface structures that remain standard. These are not derived from the carrier in this paper. They are the Standard Model structures that attach to the carrier once a wavefunction form has been realized.

The guiding rule is

$$\boxed{\text{the carrier realizes the wavefunction form; the Standard Model supplies the physical interface conditions.}}$$

Thus electric charge, chirality, helicity, gauge transport, electroweak vector mixing, CKM weighting, PMNS mixing, admissibility, and amplitudes remain Standard Model or effective field-theory structures.

3.1 Electric charge

Electric charge is not inferred from mass tier or from the carrier projector alone. In the Standard Model, electric charge is determined by the electroweak charge operator

$$Q = T_3 + \frac{Y}{2},$$

where T_3 is the third weak-isospin generator and Y is weak hypercharge [8, 9, 10, 1].

For the left-handed lepton doublet,

$$L_L = \begin{pmatrix} \nu_L \\ e_L^- \end{pmatrix}, \qquad Y = -1,$$

the upper component has

$$T_3 = +\frac{1}{2},$$

so

$$Q(\nu_L) = +\frac{1}{2} + \frac{-1}{2} = 0.$$

The lower component has

$$T_3 = -\frac{1}{2},$$

so

$$Q(e_L^-) = -\frac{1}{2} + \frac{-1}{2} = -1.$$

Therefore the lepton doublet carries the charge pattern

$$\begin{pmatrix} 0 \\ -1 \end{pmatrix}.$$

For the left-handed quark doublet,

$$Q_L = \begin{pmatrix} u_L \\ d_L \end{pmatrix}, \qquad Y = \frac{1}{3},$$

the upper component has

$$T_3 = +\frac{1}{2},$$

so

$$Q(u_L) = +\frac{1}{2} + \frac{1}{6} = +\frac{2}{3}.$$

The lower component has

$$T_3 = -\frac{1}{2},$$

so

$$Q(d_L) = -\frac{1}{2} + \frac{1}{6} = -\frac{1}{3}.$$

Therefore the quark doublet carries the charge pattern

$$\begin{pmatrix} +\frac{2}{3} \\ -\frac{1}{3} \end{pmatrix}.$$

This distinction is essential for the carrier interpretation. The carrier may realize a Dirac fermion through

$$P_D \Psi_U,$$

or a quark/color-spinor through

$$(P_D + P_\chi)\Psi_U,$$

but the physical electric charge remains the eigenvalue of the Standard Model charge operator. Thus the carrier does not say that mass determines charge. It says that the wavefunction form has been realized, after which the Standard Model electroweak representation supplies the physical charge assignment.

The color-spinor construction can still play an important role. It may explain why the fractional magnitudes

$$\frac{1}{3}, \qquad \frac{2}{3}$$

are structurally available inside the color-active carrier sector. However, the physical use and assignment of electric charge remains

$$Q = T_3 + \frac{Y}{2}.$$

In short,

$$\boxed{\text{the color-spinor says why fractional quark magnitudes are available;}}$$

$$\boxed{\text{the Standard Model says how electric charge is physically assigned.}}$$

This keeps the charge layer Standard Model compatible while preserving the carrier-level interpretation of fractional quark charge availability [7].

3.2 Chirality

Chirality is not a new carrier slot. It is a standard wavefunction characteristic of the Dirac sector. The carrier realizes the Dirac form through

$$P_D \Psi_U.$$

The Standard Model then uses the usual chiral projectors

$$P_L = \frac{1-\gamma^5}{2}, \qquad P_R = \frac{1+\gamma^5}{2}.$$

These projectors act on the four-component Dirac spinor

$$\psi = \begin{pmatrix} \psi_1 \\ \psi_2 \\ \psi_3 \\ \psi_4 \end{pmatrix}.$$

Because P_L and P_R are Dirac-sector projectors, it is useful to define their lifted carrier-space versions. Relative to the block decomposition

$$\mathbb{C}^9 = \mathbb{C}^4_{\text{scalar/vector}} \oplus \mathbb{C}^4_{\text{Dirac}} \oplus \mathbb{C}^1_{\chi},$$

define

$$P_L^{(U)} = \begin{pmatrix} 0_{4\times 4} & 0 & 0 \\ 0 & P_L & 0 \\ 0 & 0 & 0_{1\times 1} \end{pmatrix}, \qquad P_R^{(U)} = \begin{pmatrix} 0_{4\times 4} & 0 & 0 \\ 0 & P_R & 0 \\ 0 & 0 & 0_{1\times 1} \end{pmatrix}.$$

Then the left-chiral and right-chiral carrier components are

$$P_L^{(U)}\Psi_U, \qquad P_R^{(U)}\Psi_U.$$

When no confusion arises, expressions such as $P_L P_D \Psi_U$ may be read as shorthand for the left-chiral projection inside the Dirac block.

For quarks, the full carrier realization is

$$(P_D + P_\chi)\Psi_U.$$

The weak interaction still acts through the left-chiral Dirac component, so the weak access factor is represented by

$$P_L^{(U)}.$$

The color-extension component remains attached through P_χ, but chirality itself acts inside the Dirac sector. Therefore

$$\boxed{\text{chirality is a Dirac-sector wavefunction characteristic, not a new carrier component.}}$$

3.3 Helicity

Helicity is treated in the same spirit. It is not a separate carrier slot. It is a standard characteristic of a realized vector or photon state.

The carrier realizes a vector state through

$$P_V\Psi_U.$$

For a photon mode, the usual covariant form is

$$A_\mu(x) = \epsilon_\mu(k,\lambda)e^{-ik\cdot x},$$

with

$$k^2 = 0, \qquad k\cdot\epsilon(k,\lambda) = 0,$$

and helicity

$$\lambda = +1 \qquad \text{or} \qquad \lambda = -1.$$

Thus the carrier supplies the vector wavefunction form, while helicity appears in the standard polarization structure

$$\epsilon_\mu(k,\lambda).$$

So

$$\boxed{\text{helicity is a massless vector-sector wavefunction characteristic.}}$$

3.4 QCD color transport

The carrier reorganizes color-active wavefunction form, but QCD supplies the local color dynamics. Quarks are realized at the carrier level as

$$(P_D + P_\chi)\Psi_U,$$

and gluons as

$$(P_V + P_\chi)\Psi_U.$$

This carrier statement identifies the color-active form. It does not replace the QCD covariant derivative.

The QCD color-covariant derivative remains

$$D_\mu = \partial_\mu - i g_s G^a_\mu T^a,$$

where

$$T^a = \frac{\lambda^a}{2}$$

are the $SU(3)$ generators in the relevant representation, and

$$G_\mu(x) = G^a_\mu(x) T^a$$

is the gluon gauge field.

The non-Abelian field strength remains

$$G^a_{\mu\nu} = \partial_\mu G^a_\nu - \partial_\nu G^a_\mu + g_s f^{abc} G^b_\mu G^c_\nu.$$

This term contains the gluon self-interaction through the structure constants

$$f^{abc}.$$

The carrier does not remove this. Instead, it changes the interpretation of the color-active state on which this QCD transport acts.

The interface condition is therefore

$$\boxed{\text{carrier gives color-active wavefunction form; QCD gives local color transport and gluon dynamics.}}$$

The QCD dynamics remain standard; the carrier reorganizes the state-level interpretation of the color-active object being transported [11, 6, 12, 13].

3.5 Electroweak vector modes

The carrier realizes vector form through

$$P_V \Psi_U.$$

The Standard Model then resolves the physical electroweak vector bosons.

The charged weak bosons are

$$W^\pm_\mu = \frac{1}{\sqrt{2}} \left(W^1_\mu \mp i W^2_\mu \right).$$

These are the charged weak vector modes, with

$$Q(W^+) = +1, \qquad Q(W^-) = -1.$$

Their charge is not derived from the vector carrier projector alone. It comes from the Standard Model electroweak gauge structure.

The neutral photon and Z boson arise through the usual electroweak mixing:

$$\begin{pmatrix} A_\mu \\ Z_\mu \end{pmatrix} = \begin{pmatrix} \cos\theta_W & \sin\theta_W \\ -\sin\theta_W & \cos\theta_W \end{pmatrix} \begin{pmatrix} B_\mu \\ W_\mu^3 \end{pmatrix}.$$

Here B_μ is the $U(1)_Y$ gauge field, W_μ^3 is the neutral $SU(2)_L$ gauge field, and θ_W is the weak mixing angle [8, 9, 10].

Thus the carrier-level statement is simply

$$P_V \Psi_U \quad \longrightarrow \quad \text{vector realization.}$$

The Standard Model then determines whether that vector realization is resolved as

$$\gamma, \qquad Z^0, \qquad W^+, \qquad W^-.$$

Therefore

$$\boxed{\text{carrier gives vector form; electroweak theory resolves the physical vector modes.}}$$

3.6 CKM and PMNS mixing

Mixing matrices are also kept as Standard Model interface structures. They are not absorbed into the carrier.

For quarks, the CKM matrix

$$V_{\text{CKM}}$$

weights allowed charged weak routes between up-type and down-type quark mass families. It does not by itself perform the carrier-side branch transformation. Rather, it supplies the route weight for an admissible weak transition [14, 15, 1].

A down-type to up-type quark transition is represented schematically as

$$D_j \longrightarrow U_i + W^-,$$

with CKM weight

$$V_{ij}^{\text{CKM}*}.$$

The internal carrier-side operation that changes mass tier and branch orientation is separate from the CKM coefficient. Thus CKM remains a route weight, not a replacement for the carrier-side operation.

For neutrinos, the PMNS matrix

$$U_{\text{PMNS}}$$

plays the analogous role in the lepton sector, connecting neutrino flavor labels to neutrino mass eigenstates. A full neutrino carrier treatment is not required for the present interface paper. It is sufficient here to identify PMNS as the standard neutrino mixing interface that attaches to the realized lepton and neutrino output structure [16, 17, 1].

Thus

$$\boxed{V_{\text{CKM}} \text{ and } U_{\text{PMNS}} \text{ remain Standard Model route-weight and mixing interfaces.}}$$

3.7 Admissibility and amplitudes

Finally, the carrier does not replace conservation laws, admissibility conditions, or physical amplitudes. Those remain part of the process layer.

A process may be written schematically as

$$\alpha \to \beta.$$

The carrier can describe the realized wavefunction forms appearing in α and β, but physical permission and probability still require additional structures.

Let

$$\mathcal{C}_{\alpha\to\beta}$$

denote the admissibility factor enforcing conservation laws and selection rules. Let

$$\mathcal{A}_{\alpha\to\beta}$$

denote the physical amplitude supplied by the appropriate Standard Model or effective field-theory calculation. Let

$$R_{\alpha\to\beta} = |\beta\rangle\langle\alpha|$$

denote the process routing matrix.

Then a physical transition operator may be represented schematically as

$$\mathbb{T}_{\text{phys}} = \sum_{\alpha,\beta} \mathcal{A}_{\alpha\to\beta}\mathcal{C}_{\alpha\to\beta}R_{\alpha\to\beta}.$$

The carrier does not replace this layer. It supplies the wavefunction-form realizations on which this process-level structure acts.

The interface condition is therefore

$$\boxed{\text{carrier realization identifies the participating wavefunction forms;}}$$

$$\boxed{\begin{array}{c}\text{Standard Model amplitudes and admissibility determine physical process weights and}\\ \text{allowed channels.}\end{array}}$$

Together, these interface conditions define the conservative embedding used in this paper. The unified carrier reorganizes the wavefunction-form layer, while the Standard Model remains the charge, gauge, mixing, admissibility, and amplitude layer.

3.8 Representation-Level Compatibility and Scope

The preceding interface conditions can be summarized as a representation-level compatibility requirement. The unified carrier is not introduced as an alternative gauge group, and it does not replace the Hilbert-space representation theory of the Standard Model. Its role is to supply a carrier-level realization of wavefunction form. The local gauge symmetry, physical charge assignment, anomaly cancellation, and amplitude calculations remain those of the Standard Model.

For the color-active quark sector, the carrier realization is

$$\Psi_\chi(x) = (P_D + P_\chi)\Psi_U(x).$$

This identifies the quark/color-spinor carrier form. Once this form is realized, the local color dynamics are still governed by the standard $SU(3)_C$ gauge-covariant derivative,

$$D_\mu \Psi_\chi = \left(\partial_\mu - i g_s G^a_\mu T^a\right)\Psi_\chi.$$

Under a local color transformation

$$\Psi_\chi(x) \longrightarrow U(x)\Psi_\chi(x), \qquad U(x) \in SU(3)_C,$$

the gauge field transforms in the usual way,

$$G_\mu(x) \longrightarrow U(x)G_\mu(x)U^{-1}(x) + \frac{i}{g_s}(\partial_\mu U(x))U^{-1}(x),$$

so that the covariant derivative transforms covariantly:

$$D_\mu \Psi_\chi(x) \longrightarrow U(x) D_\mu \Psi_\chi(x).$$

Thus the carrier does not replace local color gauge covariance. It supplies the color-active wavefunction form on which the ordinary QCD gauge structure acts [11, 6, 12, 13, 2, 3].

The same separation applies to electric charge. The color-spinor construction may provide a carrier-level account of why fractional quark charge magnitudes such as

$$\frac{1}{3} \qquad \text{and} \qquad \frac{2}{3}$$

are structurally available in the color-active sector. However, these carrier-side magnitudes are not a replacement for the electroweak charge operator. Physical electric charge remains assigned by

$$Q = T_3 + \frac{Y}{2}.$$

Consequently, the anomaly-canceling charge and hypercharge assignments of the Standard Model are preserved, because the carrier does not alter the $SU(3)_C \times SU(2)_L \times U(1)_Y$ representation content used for physical charges and gauge couplings [8, 9, 10, 1].

This also fixes the status of the color-spinor charge result. It should be read as a carrier-side structural result:

fractional magnitudes are available in the color-active carrier sector,

not as an independent replacement for the Standard Model charge law. The physical assignment remains

$$Q = T_3 + \frac{Y}{2}.$$

In this sense, the color-spinor explains why the fractional pattern is natural inside the carrier, while the Standard Model specifies how that pattern is embedded into the electroweak representation.

A full dynamical action for the carrier-extended field is outside the scope of the present paper. The present construction requires only that the carrier-realized sectors admit the usual Standard Model gauge-covariant action. The explicit Hilbert-space completion, inner product, unitarity proof, tensor product decomposition, and Lagrangian embedding of the color-spinor carrier are therefore left to a separate technical treatment. The claim made here is only the conservative interface claim:

the carrier realizes the wavefunction form; the Standard Model supplies the gauge representation, charge assignment, and dynamics.

4 Interpretive Consequences for Physical Behaviour

The unified carrier does not merely rename Standard Model field forms. Some of its consequences are interpretive and behavioural: they change how certain physical processes are understood while preserving the Standard Model dynamics that govern them. These are not claims of new dynamics. They are interpretive consequences for the realized wavefunction state on which the Standard Model acts.

The consequences are strongest in the color sector, where the color-spinor changes the interpretation of color labels, color closure, and gluon-mediated color evolution. They also appear in weak processes, where decay can be separated into mass reassignment, weak-branch reassignment, and route weighting.

4.1 Color as carrier orientation rather than fixed label

In ordinary QCD notation, a quark field is often written with an explicit color index,

$$q^a(x), \qquad a = r, g, b.$$

This notation is successful and will not be discarded. However, it can make the color degree of freedom appear like an externally appended label attached to an otherwise ordinary quark field.

In the unified carrier, the quark/color-spinor realization is

$$\Psi_q = (P_D + P_\chi)\Psi_U.$$

The color-active component is therefore not appended after the Dirac field has already been written. It is part of the realized carrier form. The labels

$$r, \qquad g, \qquad b$$

are then interpreted as basis coordinates in an internal color space, not as primitive fixed tags attached to the quark [5, 6, 7].

Thus the carrier changes the color interpretation from

$$\text{Dirac spinor} + \text{external color label}$$

to

$$\text{color-spinor carrier realization.}$$

In this form, color is an internal orientation of the carrier state. The standard $SU(3)$ matrices still act on the color degrees of freedom, but the state on which they act has been reinterpreted.

The same logic applies to gluons. A gluon/color-vector realization is written

$$\Psi_g = (P_V + P_\chi)\Psi_U.$$

Thus quark color and gluon color both involve the same carrier color-extension sector:

$$P_\chi.$$

The difference is that quarks activate the color-extension with the Dirac sector,

$$P_D + P_\chi,$$

while gluons activate the color-extension with the vector sector,

$$P_V + P_\chi.$$

This is an interpretive consequence because it changes what the color degree of freedom is understood to be. Color is no longer merely a label carried by separate field species. It becomes an internal carrier orientation shared by quark/color-spinor and gluon/color-vector realizations.

4.2 Dynamic color closure

A second consequence is that color neutrality can be interpreted dynamically. In static label language, a meson is often described as a color–anticolor pair, while a baryon is described as a red-green-blue combination. At the carrier level, these become closure conditions on color orientations.

Here $C_i(t)$ denotes a carrier color-orientation component, not an electric charge eigenvalue. For a meson-like color closure, the carrier condition is

$$C(t) + \bar{C}(t) = 0.$$

The exposed color orientation and the corresponding anti-orientation cancel.

For a baryon-like color closure, the carrier condition is

$$C_1(t) + C_2(t) + C_3(t) = 0.$$

The three color-spinor orientations close as a singlet configuration.

This is not a change to the statement that physical hadrons are color singlets. It is a change to the interpretation of the singlet condition. The singlet is not merely the result of combining fixed labels. It is the result of a closed carrier-orientation configuration.

Thus

$$\boxed{\text{color neutrality becomes dynamic carrier closure rather than static label cancellation.}}$$

This interpretation is especially natural because QCD is already a local gauge theory. The color state is not expected to sit as a frozen label. It is acted on by local color transport, and the carrier picture makes that behaviour explicit by treating color as an evolving internal orientation.

4.3 Gluon exchange as color-spinor reorientation

QCD remains the color-transport dynamics. The covariant derivative is still

$$D_\mu = \partial_\mu - i g_s G^a_\mu T^a.$$

The non-Abelian field strength is still

$$G^a_{\mu\nu} = \partial_\mu G^a_\nu - \partial_\nu G^a_\mu + g_s f^{abc} G^b_\mu G^c_\nu.$$

The carrier does not replace either expression.

What changes is the interpretation of the color-active object being transported. A quark state is now written

$$(P_D + P_\chi)\Psi_U,$$

and a gluon state is written

$$(P_V + P_\chi)\Psi_U.$$

The QCD gauge field acts on the color-active carrier orientation.

In this interpretation, gluon exchange is not merely a symbolic swap of color labels. It is a local reorientation of color-spinor components. The state evolves under the QCD transport law, while the bound system maintains singlet closure:

$$C(t) + \bar{C}(t) = 0$$

for meson-like closure, or

$$C_1(t) + C_2(t) + C_3(t) = 0$$

for baryon-like closure.

The interpretive statement is therefore

$$\boxed{\text{gluon exchange dynamically reorients color-active carrier components while preserving singlet closure.}}$$

This preserves QCD while giving a more concrete carrier-level meaning to the color state being transported.

4.4 Fractional quark charge as structural availability

The color-spinor construction also gives a possible structural reason why fractional quark charge magnitudes are available in the color-active sector. The relevant magnitudes are

$$0, \qquad \frac{1}{3}, \qquad \frac{2}{3}, \qquad 1.$$

In particular, the quark magnitudes

$$\frac{1}{3} \qquad \text{and} \qquad \frac{2}{3}$$

arise naturally in the color-spinor charge structure [7].

This does not replace the Standard Model charge assignment. Physical electric charge remains assigned by

$$Q = T_3 + \frac{Y}{2}.$$

Thus

$$Q(u) = +\frac{2}{3}, \qquad Q(d) = -\frac{1}{3}$$

are still Standard Model charge eigenvalues. The carrier-side result has a different role. It explains why fractional magnitudes of this type are structurally available in the color-active carrier sector.

The distinction is

$$\boxed{\text{the color-spinor says why fractional quark magnitudes are available;}}$$

$$\boxed{\text{the Standard Model says how physical electric charge is assigned.}}$$

This is an important interpretive consequence because it prevents charge from being treated as an arbitrary numerical decoration of quark labels. The Standard Model assignment remains intact, but the carrier supplies a possible structural reason why the relevant fractional pattern is natural in the color-active sector.

4.5 Weak decay as mass and weak-branch reassignment

The carrier also clarifies the internal interpretation of weak decays. Not every weak decay requires a change of wavefunction form. Often the broad carrier form is preserved while internal data change.

For charged leptons, the carrier form is

$$P_D \Psi_U.$$

A decay such as

$$\mu^- \to e^- + \bar{\nu}_e + \nu_\mu$$

preserves the charged-lepton carrier form:

$$P_D\Psi_U \longrightarrow P_D\Psi_U.$$

It also preserves electric charge on the charged-lepton line:

$$Q = -1 \longrightarrow Q = -1.$$

The main carrier-side change is mass-family reassignment:

$$m_\mu \longrightarrow m_e.$$

Thus charged-lepton decay may be interpreted, on the charged lepton line, as a same-form process with mass reassignment.

For quarks, the situation is different. A down-type to up-type charged-current transition may be written

$$D_j \to U_i + W^-.$$

The broad carrier form is still quark/color-spinor:

$$(P_D + P_\chi)\Psi_U \longrightarrow (P_D + P_\chi)\Psi_U.$$

However, both the mass tier and weak branch change:

$$m_{D_j} \longrightarrow m_{U_i},$$

and

$$D_j \longrightarrow U_i.$$

The physical electric charge associated with those branches is still read by the Standard Model charge operator:

$$Q(D_j) = -\frac{1}{3}, \qquad Q(U_i) = +\frac{2}{3}.$$

The emitted weak boson carries

$$Q(W^-) = -1,$$

so charge is conserved:

$$-\frac{1}{3} = +\frac{2}{3} - 1.$$

Thus weak decays can be sorted by what changes internally:

charged lepton: mass reassignment with electric charge preserved,

quark charged current: mass reassignment plus weak-branch reassignment.

This does not change the Standard Model weak interaction. It changes the carrier-level interpretation of what the weak process is doing to the realized state.

4.6 Behavioural summary

The interpretive consequences for physical behaviour may be summarized as follows.

First, color becomes an internal carrier orientation rather than a fixed external label:

$$q^a(x) \quad \longrightarrow \quad (P_D + P_\chi)\Psi_U.$$

Second, gluons and quarks share the same color-extension sector:

$$(P_D + P_\chi)\Psi_U \quad \text{and} \quad (P_V + P_\chi)\Psi_U.$$

Third, hadronic color neutrality becomes dynamic carrier closure:

$$C(t) + \bar{C}(t) = 0,$$

$$C_1(t) + C_2(t) + C_3(t) = 0.$$

Fourth, fractional quark charge magnitudes become structurally available in the color-active carrier sector, while the physical charge assignment remains

$$Q = T_3 + \frac{Y}{2}.$$

Fifth, weak decay can be interpreted as mass reassignment, weak-branch reassignment, or both, depending on the sector.

These are not replacements for Standard Model dynamics. They are changes in the interpretation of the realized wavefunction state on which those dynamics act.

5 Operator-Level Organization

The unified carrier also clarifies the roles of the operators used to describe physical processes. Without this separation, a single transformation operator can be forced to do too many different things: change wavefunction form, change mass family, change weak branch, route the process, enforce conservation laws, and supply the physical amplitude. The carrier framework avoids this by separating these jobs.

The guiding principle is

$$\boxed{\text{carrier-form reassignment and internal process operations are distinct.}}$$

A process may change the realized carrier form, or it may preserve the broad carrier form while changing internal data such as mass tier or weak branch. These two cases should not be represented as the same kind of operation.

5.1 Carrier-form reassignment

A carrier-form transformation changes the realized wavefunction sector. This is the role of the carrier transformation operator T. Schematically,

$$T = \text{carrier-form reassignment}.$$

For a one-to-one carrier reassignment from sector A to sector B, the natural form is

$$T_{A\to B} = P_B \mathcal{U}_{BA} P_A,$$

where P_A selects the input carrier sector, P_B selects the output carrier sector, and $\mathcal{U}_{BA}$ reassigns carrier amplitude from the input slot-set to the output slot-set.

The important point is that projectors alone cannot perform this reassignment. If A and B are orthogonal carrier sectors, then

$$P_B P_A = 0.$$

Therefore a genuine carrier transformation needs an intermediate reassignment map:

$$P_A \quad \longrightarrow \quad \mathcal{U}_{BA} \quad \longrightarrow \quad P_B.$$

This is what $T_{A \to B}$ represents.

For example, a photon-pair process producing an electron–positron pair involves a change from vector-sector realizations to Dirac-sector realizations:

$$\gamma\gamma \to e^- e^+.$$

At the carrier-form level, this is represented schematically as

$$P_V \Psi_U + P_V \Psi_U \longrightarrow P_D \Psi_U + P_D \Psi_U.$$

This is a true carrier-form reassignment. The visible wavefunction form changes from vector to Dirac.

By contrast, not every decay requires such a carrier-form change. Many weak processes preserve the broad carrier form and change internal state data instead. Those cases should be represented by internal process operations, not by forcing T to do everything.

5.2 Internal process operations

An internal process operation acts inside an already-realized carrier sector. It changes quantities such as mass assignment, weak-branch assignment, or carrier orientation while preserving the broad carrier form.

We denote such an operation schematically by

$$\mathcal{O}.$$

Thus

$$\mathcal{O} = \text{internal mass, branch, or orientation operation.}$$

For charged leptons, a decay such as

$$\mu^- \to e^- + \bar{\nu}_e + \nu_\mu$$

preserves the charged-lepton carrier form:

$$P_D \Psi_U \longrightarrow P_D \Psi_U.$$

The electric charge on the charged-lepton line is also preserved:

$$Q = -1 \longrightarrow Q = -1.$$

The main carrier-side change is the mass-family reassignment

$$m_\mu \longrightarrow m_e.$$

Thus the internal operation on the charged lepton line may be written schematically as

$$\mathcal{O}^{\ell}_{\mu\to e} = \mathcal{M}_{\mu\to e},$$

where

$$\mathcal{M}_{\mu\to e} = \text{charged-lepton mass-family reassignment.}$$

For quarks, the charged-current transition has a richer internal structure. A down-type to up-type transition is written

$$D_j \to U_i + W^-.$$

The broad carrier form remains quark/color-spinor:

$$(P_D + P_\chi)\Psi_U \longrightarrow (P_D + P_\chi)\Psi_U.$$

However, the internal branch and mass tier change:

$$D_j = (|D\rangle, m_{D_j}), \qquad U_i = (|U\rangle, m_{U_i}).$$

The internal quark operation therefore separates mass-tier reassignment from weak-branch reassignment:

$$\mathcal{O}^{q}_{D_j\to U_i} = \mathcal{M}_{D_j\to U_i} \otimes B_{D\to U}.$$

Here

$$\mathcal{M}_{D_j\to U_i} = \text{mass-tier reassignment,}$$

and

$$B_{D\to U} = \text{weak-branch ladder.}$$

The reverse operation is

$$\mathcal{O}^{q}_{U_i\to D_j} = \mathcal{M}_{U_i\to D_j} \otimes B_{U\to D}.$$

Thus the carrier-level distinction is

$$\boxed{T = \text{change of realized wavefunction form,}}$$

while

$$\boxed{\mathcal{O} = \text{change of internal realized data inside a fixed form.}}$$

5.3 Branch ladders, mass reassignment, and CKM weighting

The branch-changing operator should not be interpreted as a charge operator. It is the abstract weak-branch ladder that moves a quark state from the down-type weak branch to the up-type weak branch. Charge is then read by the Standard Model electroweak charge assignment, not assigned by the branch ladder itself.

At the abstract branch level, define the two-dimensional weak branch space

$$\mathcal{H}_B = \text{span}\{|D\rangle, |U\rangle\},$$

where $|D\rangle$ denotes the down-type branch and $|U\rangle$ denotes the up-type branch. The branch ladder operators are

$$B_{D\to U} = |U\rangle\langle D|, \qquad B_{U\to D} = |D\rangle\langle U|.$$

They satisfy

$$B_{D\to U}|D\rangle = |U\rangle, \qquad B_{U\to D}|U\rangle = |D\rangle,$$

and

$$B_{D\to U}|U\rangle = 0, \qquad B_{U\to D}|D\rangle = 0.$$

The corresponding branch-charge readout is represented by

$$Q_B = -\frac{1}{3}|D\rangle\langle D| + \frac{2}{3}|U\rangle\langle U|.$$

Thus

$$Q_B|D\rangle = -\frac{1}{3}|D\rangle, \qquad Q_B|U\rangle = +\frac{2}{3}|U\rangle.$$

This branch charge readout is compatible with the Standard Model electroweak assignment

$$Q = T_3 + \frac{Y}{2}.$$

The branch ladder changes the branch; the Standard Model charge operator reads the physical charge associated with that branch.

The color-spinor realization maps the abstract branch states to carrier orientations,

$$|D\rangle \mapsto \chi_D, \qquad |U\rangle \mapsto \chi_U,$$

where

$$\chi_D = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, \qquad \chi_U = \begin{pmatrix} 1/\sqrt{2} \\ 1/\sqrt{2} \\ 0 \end{pmatrix}.$$

These carrier orientations should not be treated as the primary charge eigenbasis. The abstract states $|D\rangle$ and $|U\rangle$ carry the branch-charge readout, while χ_D and χ_U are color-spinor orientation realizations of those branches.

The carrier-orientation map is not arbitrary once the branch orientations are chosen. Since

$$\chi_D = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, \qquad \chi_U = \begin{pmatrix} 1/\sqrt{2} \\ 1/\sqrt{2} \\ 0 \end{pmatrix},$$

the angle between them is

$$\theta_{DU} = \cos^{-1}\left(\chi_D^\dagger \chi_U\right) = \cos^{-1}\left(\frac{1}{\sqrt{2}}\right) = \frac{\pi}{4}.$$

Therefore the minimal real carrier rotation from χ_D to χ_U is the rotation by $\pi/4$ in the (χ_1, χ_2) plane, leaving χ_3 fixed.

Define the generator

$$K_{12} = \begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}.$$

Then

$$\mathcal{J}^{(\chi)}_{D\to U} = \exp\left(\frac{\pi}{4} K_{12}\right).$$

Explicitly,

$$\mathcal{J}^{(\chi)}_{D\to U} = \begin{pmatrix} \cos(\pi/4) & -\sin(\pi/4) & 0 \\ \sin(\pi/4) & \cos(\pi/4) & 0 \\ 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0 \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{pmatrix}.$$

This gives

$$\mathcal{J}^{(\chi)}_{D\to U}\chi_D = \chi_U.$$

The reverse carrier-orientation map is

$$\mathcal{J}^{(\chi)}_{U\to D} = \exp\left(-\frac{\pi}{4}K_{12}\right) = \left(\mathcal{J}^{(\chi)}_{D\to U}\right)^{\dagger},$$

so that

$$\mathcal{J}^{(\chi)}_{U\to D}\chi_U = \chi_D.$$

Thus $\mathcal{J}^{(\chi)}_{D\to U}$ is the canonical minimal carrier-orientation realization of the abstract branch ladder $B_{D\to U}$.

The mass-tier reassignment is separate from the branch change. For a transition from the down-type mass tier m_{D_j} to the up-type mass tier m_{U_i}, define

$$\mathcal{M}_{D_j\to U_i} = |m_{U_i}\rangle\langle m_{D_j}|.$$

Similarly,

$$\mathcal{M}_{U_i\to D_j} = |m_{D_j}\rangle\langle m_{U_i}|.$$

Thus the carrier-side internal quark operation is

$$\mathcal{O}^q_{D_j\to U_i} = \mathcal{M}_{D_j\to U_i} \otimes B_{D\to U},$$

and the reverse operation is

$$\mathcal{O}^q_{U_i\to D_j} = \mathcal{M}_{U_i\to D_j} \otimes B_{U\to D}.$$

Including left-chiral weak access and the preservation of QCD color during the charged weak transition gives the Standard Model interface form

$$\mathcal{W}^{(-)}_q = \sum_{i,j} V^{\mathrm{CKM}*}_{ij}\left(P^{(U)}_L \otimes I_{\mathrm{color}} \otimes \mathcal{M}_{D_j\to U_i} \otimes B_{D\to U}\right),$$

and

$$\mathcal{W}^{(+)}_q = \sum_{i,j} V^{\mathrm{CKM}}_{ij}\left(P^{(U)}_L \otimes I_{\mathrm{color}} \otimes \mathcal{M}_{U_i\to D_j} \otimes B_{U\to D}\right).$$

Here

$$P^{(U)}_L$$

is the left-chiral projector lifted to the Dirac block of the unified carrier,

$$I_{\mathrm{color}}$$

indicates that the charged weak transition preserves QCD color, $\mathcal{M}$ changes the mass tier, B changes the weak branch, and V_{CKM} supplies the Standard Model route weight.

Therefore the branch ladder does not assign charge, CKM does not perform the branch transformation, and the color-spinor orientation map is not the QCD color-transport law. The roles are separated:

$$B_{D\to U} = \text{abstract weak-branch change},$$
$$\mathcal{J}^{(\chi)}_{D\to U} = \text{carrier-orientation realization of that branch change},$$
$$\mathcal{M}_{D_j\to U_i} = \text{mass-tier reassignment},$$
$$V^{\mathrm{CKM}*}_{ij} = \text{Standard Model route weight},$$

and

$$Q = T_3 + \frac{Y}{2} = \text{physical electric-charge assignment}.$$

5.4 PMNS as the lepton-sector mixing interface

The PMNS matrix plays the analogous role for neutrino mixing in the lepton sector. The present paper does not require a complete neutrino carrier theory. It only needs the interface placement.

The PMNS matrix is written

$$U_{\text{PMNS}}.$$

It relates neutrino flavor labels to neutrino mass eigenstates. In the present framework, it remains a Standard Model mixing interface attached to the lepton and neutrino output structure.

For charged lepton decay, the charged-lepton line may preserve its charge branch while changing mass family:

$$\mu^- \to e^-.$$

The neutrino output layer carries the relevant flavor and mass mixing structure, which is weighted by

$$U_{\text{PMNS}}.$$

Thus PMNS is treated in parallel with CKM:

$$\boxed{\text{CKM weights quark weak routes;}}$$

$$\boxed{\text{PMNS weights neutrino flavor–mass mixing routes.}}$$

Neither matrix is absorbed into the carrier. Both remain Standard Model interface structures.

5.5 Process routing

Carrier-form reassignment and internal operations are still not the full physical process. A process also needs a route label. This is the role of the routing matrix

$$R_{\alpha\to\beta}.$$

For a process channel

$$\alpha \to \beta,$$

we write

$$R_{\alpha\to\beta} = |\beta\rangle\langle\alpha|.$$

This operator records the process-space input and output. It does not perform the carrier reassignment by itself, and it does not supply the physical amplitude.

Thus

$$R_{\alpha\to\beta} = \text{process routing},$$

while

$$T = \text{carrier-form reassignment},$$

and

$$\mathcal{O} = \text{internal operation inside a realized form}.$$

For example, the route

$$\gamma\gamma \to e^-e^+$$

is distinct from the carrier-form reassignment

$$P_V + P_V \to P_D + P_D.$$

Similarly, the route

$$d \to u + W^-$$

is distinct from the internal operation

$$\mathcal{M}_{d\to u} \otimes B_{D\to U}.$$

This distinction keeps the process notation modular. The route identifies which channel is under consideration. The carrier and internal operations describe what must change in the realized state. The amplitude and admissibility factors then determine whether and how strongly the process occurs.

5.6 Admissibility and amplitude

A process must also satisfy conservation laws and selection rules. Let

$$\mathcal{C}_{\alpha\to\beta}$$

denote the admissibility factor for the route

$$\alpha \to \beta.$$

This factor encodes conservation of electric charge, color singlet conditions, spin/angular momentum constraints, energy-momentum constraints, and other selection rules appropriate to the process.

The physical amplitude is denoted

$$\mathcal{A}_{\alpha\to\beta}.$$

This amplitude is supplied by the Standard Model or by the appropriate effective field theory. The carrier does not replace the amplitude calculation.

Thus a physical transition operator may be written schematically as

$$\mathbb{T}_{\text{phys}} = \sum_{\alpha,\beta} \mathcal{A}_{\alpha\to\beta}\mathcal{C}_{\alpha\to\beta}R_{\alpha\to\beta}.$$

The carrier-level transformation and internal operation determine the wavefunction-form and state-data changes associated with a route. The admissibility factor determines whether the route is physically allowed. The amplitude determines the process weight.

This gives the full role separation:

$$T = \text{carrier-form reassignment},$$

$$\mathcal{O} = \text{internal state operation},$$

$$R = \text{route label},$$

$$\mathcal{C} = \text{admissibility},$$

$$\mathcal{A} = \text{amplitude}.$$

5.7 Operator-level summary

The operator-level organization may be summarized by separating three kinds of change.

First, a process may change carrier form:

$$P_A \Psi_U \longrightarrow P_B \Psi_U.$$

This is handled by

$$T_{A\to B} = P_B \mathcal{U}_{BA} P_A.$$

Second, a process may preserve carrier form but change internal state data:

$$P_A \Psi_U \longrightarrow P_A \Psi_U,$$

with

$$m_j \longrightarrow m_i,$$

or

$$D_j \longrightarrow U_i.$$

This is handled by an internal operation

$$\mathcal{O}.$$

Third, a physical process must be routed, admitted, and weighted:

$$R_{\alpha\to\beta}, \qquad \mathcal{C}_{\alpha\to\beta}, \qquad \mathcal{A}_{\alpha\to\beta}.$$

This separation is one of the main organizational benefits of the unified carrier. It prevents carrier-form reassignment, internal decay flow, branch change, route selection, conservation conditions, and amplitudes from being collapsed into one overloaded transformation symbol. The result is a cleaner interface between the carrier and the Standard Model process layer.

6 Structural Streamlining and Complexity Reduction

The preceding sections described the interpretive and operator-level consequences of the unified carrier. The present section summarizes the structural streamlining achieved by the framework. This is not a claim of new dynamics. It is a claim about representational organization: the carrier reduces the number of separate wavefunction forms that must be introduced independently, while preserving the Standard Model structures that determine physical dynamics.

The guiding statement is

$$\boxed{\text{the unified carrier preserves Standard Model dynamics while reducing representational complexity.}}$$

This kind of reduction is meaningful even when the numerical predictions remain those of the Standard Model. A formulation can be useful if it clarifies what kind of object is being described, separates operator roles, or exposes common structure behind previously separate descriptions.

6.1 Reduction of field-form fragmentation

In the usual presentation, several wavefunction forms appear as separate mathematical objects:

scalar fields, vector fields, Dirac spinors, quark fields with color, gluon fields with color.

Each is successful. The unified carrier does not deny their success. Instead, it reorganizes them as realized sectors of one carrier:

$$\Psi_U = \begin{pmatrix} \phi \\ A_x \\ A_y \\ A_z \\ \psi_1 \\ \psi_2 \\ \psi_3 \\ \psi_4 \\ \chi_C \end{pmatrix}.$$

The field-form reductions are

$$P_0\Psi_U \to \text{scalar form},$$

$$P_V\Psi_U \to \text{vector form},$$

$$P_D\Psi_U \to \text{Dirac form},$$

$$(P_D + P_\chi)\Psi_U \to \text{quark/color-spinor form},$$

and

$$(P_V + P_\chi)\Psi_U \to \text{gluon/color-vector form}.$$

Thus the carrier compresses the visible field-form taxonomy into one realization grammar. The Standard Model then supplies the physical charge, gauge transport, mixing, and amplitudes attached to those realized forms.

The streamlining is therefore not

many fields are removed,

but rather

many field forms are organized as sectors of one carrier.

This distinction matters. The validated physics is preserved, while the representational layer is made more compact.

6.2 Shared color-extension structure

The largest reduction of representational complexity occurs in the color sector. In ordinary notation, quarks and gluons carry color in different field forms. A quark may be written with a color index,

$$q^a(x), \qquad a = r, g, b,$$

while the gluon appears through the adjoint gauge field

$$G^a_\mu(x)T^a.$$

This is correct Standard Model notation, but it can obscure the question of what kind of state-level structure carries color.

The carrier reorganizes this by introducing one color-extension slot:

$$\chi_C.$$

A quark/color-spinor realization uses

$$(P_D + P_\chi)\Psi_U,$$

while a gluon/color-vector realization uses

$$(P_V + P_\chi)\Psi_U.$$

Thus quark color and gluon color are no longer introduced by completely separate bookkeeping devices. They both involve the same color-extension sector, activated with different wavefunction-form sectors.

This gives the structural reduction

$$\text{Dirac spinor plus external color label} \quad \longrightarrow \quad \text{color-spinor carrier realization},$$

and

$$\text{vector field plus color structure} \quad \longrightarrow \quad \text{color-vector carrier realization}.$$

The Standard Model color dynamics remain unchanged:

$$D_\mu = \partial_\mu - i g_s G_\mu^a T^a,$$

and

$$G_{\mu\nu}^a = \partial_\mu G_\nu^a - \partial_\nu G_\mu^a + g_s f^{abc} G_\mu^b G_\nu^c.$$

The carrier does not replace these expressions. It provides a cleaner state-level object on which these expressions act.

6.3 Color labels as basis coordinates

A further streamlining occurs in the interpretation of the labels

$$r, \qquad g, \qquad b.$$

In the carrier picture, these are not treated as primitive physical tags attached to an otherwise colorless quark. They are basis coordinates inside a color-active carrier state space.

The color-spinor construction begins from the carrier

$$E(\theta) = e^{i\theta} + j \sin\left(\frac{\theta}{4}\right),$$

and extracts the three color sectors

$$c_0(\theta) = \sin\left(\frac{\theta}{4}\right),$$

$$c_1(\theta) = \sin\left(\frac{\theta}{4} + \frac{2\pi}{3}\right),$$

$$c_2(\theta) = \sin\left(\frac{\theta}{4} + \frac{4\pi}{3}\right).$$

These satisfy

$$c_0(\theta) + c_1(\theta) + c_2(\theta) = 0.$$

Thus the color basis appears as a closed internal triplet structure.

This allows the interpretation

$$r, g, b \quad \longrightarrow \quad \text{basis coordinates in an } SU(3)\text{-closed carrier orbit.}$$

The physical content is not that a quark carries a fixed observable color label. The physical content is that the state belongs to a color-active carrier class on which the $SU(3)$ gauge structure acts.

This reduces conceptual load because it separates

$$\text{basis coordinate}$$

from

$$\text{physical carrier state.}$$

6.4 Sector characteristics stay inside their sectors

The carrier also reduces complexity by keeping wavefunction characteristics inside the appropriate realized sectors instead of turning them into additional carrier slots.

Chirality belongs inside the Dirac sector. In the carrier notation, the Dirac sector is selected by

$$P_D \Psi_U.$$

The usual chiral projectors are

$$P_L = \frac{1 - \gamma^5}{2}, \qquad P_R = \frac{1 + \gamma^5}{2}.$$

When lifted to the carrier space, these become

$$P_L^{(U)}, \qquad P_R^{(U)}.$$

Thus left-chiral and right-chiral access are represented by

$$P_L^{(U)} \Psi_U, \qquad P_R^{(U)} \Psi_U.$$

There is no need to add a separate chirality slot to the carrier.

Similarly, helicity belongs inside the vector/photon realization. For a photon mode,

$$A_\mu(x) = \epsilon_\mu(k, \lambda) e^{-ik\cdot x},$$

with

$$\lambda = \pm 1.$$

The carrier supplies

$$P_V \Psi_U,$$

and the standard polarization structure supplies the helicity state.

This keeps the carrier compact. The carrier realizes field form; sector-specific wavefunction characteristics remain inside the realized sector.

6.5 Charge assignment remains external to mass bookkeeping

Another important reduction is the separation of charge from mass family. Without a clear interface, one might incorrectly try to infer charge from the mass tier:

$$e, \mu, \tau, \qquad u, c, t, \qquad d, s, b.$$

The Standard Model does not do this. It assigns electric charge through

$$Q = T_3 + \frac{Y}{2}.$$

The carrier therefore separates three roles:

$$\text{wavefunction form} \quad \longrightarrow \quad P_0,\ P_V,\ P_D,\ P_\chi,$$

$$\text{electric charge} \quad \longrightarrow \quad Q = T_3 + \frac{Y}{2},$$

and

$$\text{mass family} \quad \longrightarrow \quad m_i.$$

For charged leptons,

$$e^-, \qquad \mu^-, \qquad \tau^-$$

share the same charge,

$$Q = -1,$$

but differ by mass family:

$$m_e, \qquad m_\mu, \qquad m_\tau.$$

For quarks,

$$u, c, t$$

share the up-type charge,

$$Q = +\frac{2}{3},$$

while

$$d, s, b$$

share the down-type charge,

$$Q = -\frac{1}{3}.$$

The mass family then distinguishes the members within each branch.

This is a streamlining because it prevents charge, mass, and carrier form from being conflated. The carrier gives form, the Standard Model gives charge, and the mass tier gives family.

6.6 Transformation roles are separated

The unified carrier also reduces complexity in process notation. Instead of using one transformation symbol for every kind of change, the framework separates roles:

$$T = \text{carrier-form reassignment},$$

$$\mathcal{O} = \text{internal mass, branch, or orientation operation},$$

$$R = \text{process routing},$$

$$\mathcal{C} = \text{admissibility and conservation},$$

$$\mathcal{A} = \text{amplitude}.$$

This separation makes it clear that different physical processes require different kinds of operations.

A cross-form process such as

$$\gamma\gamma \to e^- e^+$$

involves a carrier-form change:

$$P_V + P_V \longrightarrow P_D + P_D.$$

This is a T-type process.

A quark charged-current process such as

$$d \to u + W^-$$

preserves the broad quark/color-spinor form:

$$(P_D + P_\chi)\Psi_U \longrightarrow (P_D + P_\chi)\Psi_U,$$

but changes internal data:

$$m_d \longrightarrow m_u,$$

and

$$D \longrightarrow U.$$

At the abstract branch level, this branch change is represented by

$$B_{D\to U} = |U\rangle\langle D|.$$

At the carrier-orientation level, it may be realized by a color-spinor orientation map such as

$$\mathcal{J}^{(\chi)}_{D\to U}.$$

The full weak route is then weighted by CKM:

$$V^*_{ud}\mathcal{O}^q_{d\to u}.$$

The notation therefore becomes more organized:

$$T \neq \mathcal{O} \neq R \neq \mathcal{C} \neq \mathcal{A}.$$

Each object has its own responsibility.

6.7 Standard Model structures remain recognizable

A major requirement of this paper is that the Standard Model interface remain recognizable to a Standard Model reader. For this reason, the usual symbols are preserved:

$$Q = T_3 + \frac{Y}{2},$$

$$P_L = \frac{1-\gamma^5}{2}, \qquad P_R = \frac{1+\gamma^5}{2},$$

$$D_\mu = \partial_\mu - i g_s G^a_\mu T^a,$$

$$W^\pm_\mu = \frac{1}{\sqrt{2}} \left(W^1_\mu \mp i W^2_\mu \right),$$

$$\begin{pmatrix} A_\mu \\ Z_\mu \end{pmatrix} = \begin{pmatrix} \cos\theta_W & \sin\theta_W \\ -\sin\theta_W & \cos\theta_W \end{pmatrix} \begin{pmatrix} B_\mu \\ W^3_\mu \end{pmatrix},$$

$$V_{\text{CKM}}, \qquad U_{\text{PMNS}}.$$

The carrier notation is used only where the carrier changes the representation layer:

$$\Psi_U, \qquad P_0, \qquad P_V, \qquad P_D, \qquad P_\chi.$$

This creates a clean separation between new notation and standard interface notation.

6.8 Structural summary

The structural streamlining may be summarized in the following reductions:

$$\text{many separate wavefunction forms} \quad \longrightarrow \quad \text{one carrier with sector projectors},$$

$$\text{external color labels} \quad \longrightarrow \quad \text{internal color-extension orientation},$$

$$\text{separate quark and gluon color bookkeeping} \quad \longrightarrow \quad \text{shared } P_\chi \text{ participation},$$

$$\text{static color-label cancellation} \quad \longrightarrow \quad \text{dynamic carrier closure},$$

$$\text{ambiguous transformation symbol} \quad \longrightarrow \quad T,\ \mathcal{O},\ R,\ \mathcal{C},\ \mathcal{A} \text{ with separate roles},$$

and

$$\text{mass, charge, and carrier form mixed together} \quad \longrightarrow \quad \text{mass tier, charge operator, and carrier sector separated.}$$

The result is not a replacement of the Standard Model. It is a reduced-complexity interface:

$$\boxed{\text{the carrier organizes field form; the Standard Model supplies physical dynamics.}}$$

This is the structural value of the unified wavefunction. It preserves the validated theory while giving its wavefunction forms a common carrier grammar.

7 Conclusion

This paper has developed a lean interface between the unified carrier wavefunction and the Standard Model. The purpose has not been to replace the Standard Model, reconstruct its full Lagrangian, or alter its validated dynamics. The purpose has been to identify the minimal touchpoints where the carrier reorganizes wavefunction form while the Standard Model continues to supply charge, gauge dynamics, mixing, admissibility, and amplitudes.

The central object is the unified carrier

$$\Psi_U = \begin{pmatrix} \phi \\ A_x \\ A_y \\ A_z \\ \psi_1 \\ \psi_2 \\ \psi_3 \\ \psi_4 \\ \chi_C \end{pmatrix},$$

with block structure

$$1 + 3 + 4 + 1 = 9.$$

The scalar, vector, Dirac, and color-extension sectors are selected by

$$P_0, \qquad P_V, \qquad P_D, \qquad P_\chi,$$

with

$$P_0 + P_V + P_D + P_\chi = I_9.$$

The vector slot is displayed in the carrier as a minimal spatial vector chart; at the Standard Model interface, the usual covariant notation such as A_μ, W_μ^a, and G_μ^a is restored.

From these projectors, the familiar wavefunction forms are realized as

$$P_0\Psi_U \to \text{scalar form},$$

$$P_V\Psi_U \to \text{vector form},$$

$$P_D\Psi_U \to \text{Dirac form},$$

$$(P_D + P_\chi)\Psi_U \to \text{quark/color-spinor form},$$

and

$$(P_V + P_\chi)\Psi_U \to \text{gluon/color-vector form}.$$

This is the first main result of the interface. The carrier absorbs the field-form bookkeeping. Scalar, vector, Dirac, quark/color-spinor, and gluon/color-vector wavefunction forms do not need to be treated as unrelated mathematical species. They can be organized as realized sectors of one carrier.

At the same time, the Standard Model interface remains intact. Electric charge is not inferred from the carrier projector or from mass tier. It remains the eigenvalue of the electroweak charge operator

$$Q = T_3 + \frac{Y}{2}.$$

Chirality remains the standard Dirac-sector projection

$$P_L = \frac{1-\gamma^5}{2}, \qquad P_R = \frac{1+\gamma^5}{2}.$$

When these projectors are used inside the unified carrier, they are lifted to the Dirac block as

$$P_L^{(U)}, \qquad P_R^{(U)}.$$

QCD color transport remains governed by

$$D_\mu = \partial_\mu - i g_s G_\mu^a T^a,$$

with non-Abelian field strength

$$G_{\mu\nu}^a = \partial_\mu G_\nu^a - \partial_\nu G_\mu^a + g_s f^{abc} G_\mu^b G_\nu^c.$$

Electroweak vector modes remain resolved through

$$W_\mu^\pm = \frac{1}{\sqrt{2}} \left(W_\mu^1 \mp i W_\mu^2 \right)$$

and

$$\begin{pmatrix} A_\mu \\ Z_\mu \end{pmatrix} = \begin{pmatrix} \cos\theta_W & \sin\theta_W \\ -\sin\theta_W & \cos\theta_W \end{pmatrix} \begin{pmatrix} B_\mu \\ W_\mu^3 \end{pmatrix}.$$

The CKM and PMNS matrices remain Standard Model mixing and route-weight interfaces:

$$V_{\mathrm{CKM}}, \qquad U_{\mathrm{PMNS}}.$$

Thus the carrier is not a substitute for

$$SU(3)_C \times SU(2)_L \times U(1)_Y.$$

Rather, the carrier supplies a common wavefunction-form layer on which the Standard Model gauge structures act. In this sense, the carrier replaces neither gauge symmetry nor field dynamics. It reorganizes the state-form grammar beneath them.

The strongest reorganization occurs in the QCD sector. In the carrier picture, color is not treated as an external r, g, b tag appended to a Dirac spinor. Instead, color becomes an internal color-extension orientation. Quarks are realized by

$$(P_D + P_\chi)\Psi_U,$$

and gluons by

$$(P_V + P_\chi)\Psi_U.$$

The same color-extension sector therefore participates in both quark/color-spinor and gluon/color-vector realizations. QCD still supplies the local color transport and non-Abelian dynamics, but the meaning of the color state being transported is sharpened.

This also changes the interpretation of color closure. Here $C_i(t)$ denotes a carrier color-orientation component, not an electric charge eigenvalue. Meson-like closure may be written

$$C(t) + \bar{C}(t) = 0,$$

while baryon-like closure may be written

$$C_1(t) + C_2(t) + C_3(t) = 0.$$

Color neutrality is then interpreted as dynamic carrier-orientation closure rather than static color-label cancellation. Gluon exchange becomes the local QCD-mediated reorientation of color-active carrier components while singlet closure is preserved.

The color-spinor construction also supplies a meaningful structural result for fractional quark charge. It does not replace the Standard Model charge operator. Instead, it provides a carrier-level reason why the fractional magnitudes

$$\frac{1}{3} \qquad \text{and} \qquad \frac{2}{3}$$

are naturally available in the color-active sector. The Standard Model still determines physical electric charge through

$$Q = T_3 + \frac{Y}{2}.$$

Thus the correct division is

$$\boxed{\text{the color-spinor says why fractional quark magnitudes are available;}}$$

$$\boxed{\text{the Standard Model says how electric charge is assigned.}}$$

The paper has also separated different kinds of transformations. A carrier-form transformation is represented by

$$T_{A\to B} = P_B \mathcal{U}_{BA} P_A.$$

This applies when the realized wavefunction form changes, such as in a process schematically involving

$$P_V + P_V \longrightarrow P_D + P_D.$$

By contrast, many weak processes preserve the broad carrier form while changing internal data. A charged lepton decay may preserve

$$P_D \Psi_U \longrightarrow P_D \Psi_U$$

while changing mass family. A quark charged-current transition may preserve

$$(P_D + P_\chi)\Psi_U \longrightarrow (P_D + P_\chi)\Psi_U$$

while changing both mass tier and weak branch.

For quarks, the abstract weak branch space is

$$\mathcal{H}_B = \operatorname{span}\{|D\rangle, |U\rangle\}.$$

The branch ladder operators are

$$B_{D\to U} = |U\rangle\langle D|, \qquad B_{U\to D} = |D\rangle\langle U|.$$

The corresponding branch-charge readout is

$$Q_B = -\frac{1}{3}|D\rangle\langle D| + \frac{2}{3}|U\rangle\langle U|.$$

This is compatible with the Standard Model electroweak assignment

$$Q = T_3 + \frac{Y}{2}.$$

The branch ladder changes the weak branch; it does not assign electric charge.

The color-spinor realization maps the abstract branches to carrier orientations,

$$|D\rangle \mapsto \chi_D, \qquad |U\rangle \mapsto \chi_U,$$

with

$$\chi_D = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, \qquad \chi_U = \begin{pmatrix} 1/\sqrt{2} \\ 1/\sqrt{2} \\ 0 \end{pmatrix}.$$

A minimal carrier-orientation realization of the branch change is

$$\mathcal{J}^{(\chi)}_{D\to U} = \begin{pmatrix} \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0 \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{pmatrix},$$

which satisfies

$$\mathcal{J}^{(\chi)}_{D\to U}\chi_D = \chi_U.$$

This geometric orientation map is distinct from the abstract branch ladder $B_{D\to U}$, and both are distinct from the Standard Model charge operator.

The mass-tier reassignment is

$$\mathcal{M}_{D_j\to U_i} = |m_{U_i}\rangle\langle m_{D_j}|.$$

Therefore the carrier-side internal quark operation is

$$\mathcal{O}^q_{D_j\to U_i} = \mathcal{M}_{D_j\to U_i} \otimes B_{D\to U}.$$

Including left-chiral weak access, preservation of QCD color, and CKM route weighting gives

$$\mathcal{W}^{(-)}_q = \sum_{i,j} V^{\mathrm{CKM}*}_{ij} \left(P^{(U)}_L \otimes I_{\mathrm{color}} \otimes \mathcal{M}_{D_j\to U_i} \otimes B_{D\to U} \right).$$

The reverse direction is

$$\mathcal{W}^{(+)}_q = \sum_{i,j} V^{\mathrm{CKM}}_{ij} \left(P^{(U)}_L \otimes I_{\mathrm{color}} \otimes \mathcal{M}_{U_i\to D_j} \otimes B_{U\to D} \right).$$

This makes the operator roles explicit. The weak decay-flow operation performs the mass and branch change; CKM supplies the Standard Model route weight; the identity I_{color} indicates that the charged weak transition preserves QCD color.

The broader process layer remains separate. The routing matrix

$$R_{\alpha\to\beta} = |\beta\rangle\langle\alpha|$$

identifies the channel, the admissibility factor

$$\mathcal{C}_{\alpha\to\beta}$$

enforces conservation and selection rules, and the amplitude

$$\mathcal{A}_{\alpha\to\beta}$$

is supplied by the appropriate Standard Model or effective field-theory calculation. A physical transition operator may therefore be written schematically as

$$\mathbb{T}_{\text{phys}} = \sum_{\alpha,\beta} \mathcal{A}_{\alpha\to\beta}\mathcal{C}_{\alpha\to\beta}R_{\alpha\to\beta}.$$

The carrier supplies the wavefunction-form realizations; the Standard Model supplies the process physics.

The resulting framework gives three kinds of value. First, it produces interpretive consequences for physical behaviour by reinterpreting color closure, gluon-mediated color reorientation, fractional quark charge availability, and weak decay as mass or branch reassignment. Second, it provides operator-level organization by separating carrier-form reassignment from internal operations, branch ladders, carrier-orientation realizations, routing, admissibility, and amplitudes. Third, it reduces representational complexity by placing scalar, vector, Dirac, quark/color-spinor, and gluon/color-vector forms inside one carrier grammar while preserving the familiar Standard Model interface.

This is the main conclusion:

$$\boxed{\text{The carrier tells what kind of wavefunction has been realized;}}$$

$$\boxed{\begin{array}{c}\text{The Standard Model specifies how that realization carries charge, transforms locally,}\\ \text{mixes, decays, and produces physical amplitudes.}\end{array}}$$

Therefore the unified carrier should be understood as a wavefunction-form interface layer. It does not compete with the Standard Model as a dynamics theory. It provides a common carrier grammar beneath the Standard Model field forms and identifies the touchpoints where the validated Standard Model structures attach. The final result is a lean embedding:

$$\boxed{\text{the carrier absorbs field-form bookkeeping;}}$$

$$\boxed{\text{the Standard Model supplies charge, gauge dynamics, mixing weights, admissibility, and amplitudes.}}$$

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