Gravity Inside the Dirac Adjoint: From Lorentz Boosts to First-Order Gravitational Dynamics in the Qg Framework

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Abstract

This paper extends earlier work on the biquaternionic (BQ) representation of the Dirac algebra by introducing the gravitational rotor field $Q_g(x) \in \mathrm{Spin}(1,3)_{\mathbb{C}}$ and analysing its consequences for the structure of relativistic dynamics The formalism distinguishes between the special-relativistic (Kinematic) boost, which acts on spinor components within a fixed background, and the gravitational (G-) boost, which acts on the basis itself through the adjoint $\not{G} = Q_g \beta_0 Q_g^{-1}$. This difference transforms the notion of curvature from an external geometric property into an internal rotation of the Dirac algebra. The resulting Dirac–Q_g Lagrangian is first order in derivatives and defines both the gravitational connection and its conserved current within the same algebra. General Relativity is recovered as a slow-field limit, while the formulation remains compatible with the Standard Model and quantum chromodynamics. The approach is exploratory: it proposes a compact algebraic framework in which geometry, mass, and quantisation emerge as interdependent aspects of a single Dirac medium.

Contents

1 Introduction

The present study continues a programme that seeks to reformulate the interaction between quantum theory and gravitation inside the Dirac algebra itself [1, 2]. The first paper in this series reconstructed the Lorentz and Dirac operators within the biquaternionic (BQ) formalism, revealing that boosts and rotations can be written as internal rotor operations acting on slashed quantities $\not{P} = \beta^\mu P_\mu$. The second paper extended this structure by identifying the gravitational rotor field $Q_g(x)$, which acts on the local time basis rather than on spinor components. The resulting adjoint $\not{G} = Q_g \beta_0 Q_g^{-1}$ defines both the gravitational lapse and shift and introduces the concept of a *gravitational boost* distinct from the special-relativistic one.

In the formulation developed here, the Dirac Lagrangian is augmented by the field connection $(\not{\partial} Q_g)Q_g^{-1}$, yielding a covariant operator that replaces the metric and spin connection of conventional general relativity. The theory remains first order in derivatives, in analogy with the Dirac equation, and embeds gravitational curvature as an internal commutator $F_{\mu\nu} = [\not{D}_\mu, \not{D}_\nu]$. This expresses gravity not as an external geometry but as a dynamical property of the Dirac medium itself.

The paper proceeds by clarifying the algebraic difference between kinematic and gravitational boosts (Sections 2–4), tracing the origin of the gravitational rotor from the dual freedom of basis and component transformations (Section 6), and analysing why gravity in this picture cannot be regarded as a gauge symmetry (Section 7). Subsequent sections compare the resulting framework with General Relativity, geometric algebra, pilot-wave theory, and other established traditions, before turning to the structural implications of replacing second-order Einstein dynamics by a first-order rotor formulation.

This work follows the tradition of algebraic reformulations of relativity and quantum theory initiated by Dirac [3], developed in the geometric algebra approach of Hestenes [4], and framed in the standard geometric language of general relativity as compiled by Misner, Thorne, and Wheeler [5]. The analysis also draws on the Arnowitt–Deser–Misner (ADM) formulation of general relativity, in which spacetime is decomposed into lapse and shift functions [6]. Within the present framework these quantities appear naturally inside the adjoint $\slashed{G} = Q_g \beta_0 Q_g^{-1}$, providing an algebraic realisation of the ADM lapse and shift in the Dirac–BQ language.

The approach does not aim to replace existing quantum field theories, including quantum chromodynamics and the electroweak model. It addresses the complementary problem of the geometric background in which such gauge theories operate. The intent is to provide a unified algebraic environment in which curvature, inertia, and quantisation arise from a common principle: the self-consistent rotation of the Dirac adjoint field.

Throughout, natural units with $c = 1$ are used, and $\slashed{A} = \beta^\mu A_\mu$ denotes the standard slashed notation in the Dirac–BQ basis.

2 The Qg-enhanced Dirac Lagrangian

In the BQ-Dirac framework, the gravitational rotor field $Q_g(x) \in \mathrm{Spin}(1,3)_{\mathbb{C}}$ defines both the local time basis and the gravitational connection by conjugation and differentiation:

$$\slashed{G} = Q_g \, \beta_0 \, Q_g^{-1}, \tag{1}$$

$$\slashed{C} = \slashed{\partial} + (\slashed{\partial} Q_g) Q_g^{-1}. \tag{2}$$

This immediately yields a gravitationally extended Dirac Lagrangian,

$$\mathcal{L}_{\text{Dirac}} = \frac{i\hbar}{2} \Big(\Psi^\dagger \slashed{G} \slashed{C} \Psi - (\slashed{C}\Psi)^\dagger \slashed{G} \Psi \Big) - mc \, \Psi^\dagger \slashed{G} \Psi, \tag{3}$$

which reduces to the flat-space Dirac Lagrangian when $Q_g \to 1$. The operator $\slashed{C}$ generalizes the derivative to a covariant form containing the adjoint field connection,

$$\slashed{D} = \slashed{\partial} + \slashed{C}, \qquad \slashed{C} = (\slashed{\partial} Q_g) Q_g^{-1}. \tag{4}$$

The corresponding Dirac equation reads

$$i\hbar(\slashed{\partial} + \slashed{V} + \slashed{C})\Psi - mc\,\Psi = 0, \qquad \slashed{V} = \frac{1}{2} \slashed{G}^{-1} (\slashed{\partial} \slashed{G}), \tag{5}$$

and yields the conserved current

$$J = \Psi^\dagger \slashed{G} \beta \Psi, \qquad \slashed{\partial} J = 0. \tag{6}$$

The gravitational field thus becomes an *adjoint field* within the same algebra that defines the spinor, rather than an external spacetime geometry. This construction transforms the traditional view of spacetime curvature into an internal rotation of the Dirac algebra itself.

3 SR and Gravitational Boosts

3.1 The SR (K-) Boost

The standard SR Lorentz boost in the Dirac representation is

$$\Lambda_D^{-1} = \begin{bmatrix} \cosh \frac{\psi}{2} \, \hat{1} & -\sinh \frac{\psi}{2} \, \sigma_I \\ -\sinh \frac{\psi}{2} \, \sigma_I & \cosh \frac{\psi}{2} \, \hat{1} \end{bmatrix} = \hat{1} \cosh \frac{\psi}{2} - \alpha_I \sinh \frac{\psi}{2} = \hat{1} \, e^{-(\alpha_I \psi/2)}. \tag{7}$$

In the Weyl representation the boost acts diagonally:

$$\Lambda_W = \begin{pmatrix} e^{+\sigma_I \psi/2} & 0 \\ 0 & e^{-\sigma_I \psi/2} \end{pmatrix}, \qquad \Lambda_D = S^{-1} \Lambda_W S. \tag{8}$$

Thus, SR boosts are naturally defined in the Weyl environment, acting on massless chiral components. To perform a boost, one transforms Dirac $\to$ Weyl, applies the boost, then transforms back.

3.2 The Gravitational (G-) Boost

In contrast, the gravitational rotor acts directly within the Dirac algebra on the basis itself:

$$\not{G} = Q_g \, \beta_0 \, Q_g^{-1} = e^{-(\alpha_I \psi_g/2)} \beta_0 e^{+(\alpha_I \psi_g/2)}. \tag{9}$$

This defines a local time axis and spatial inflow encoded in $\psi_g(x)$, which represents a real gravitational rapidity field. Here, Q_g is not a coordinate transformation but a *field operator* determining the physical curvature of the Dirac clock.

The gravitational "boost" therefore deforms the local adjoint rather than the spinor components:

$$\Psi^\dagger \beta_0 \Psi \;\longrightarrow\; \Psi^\dagger \not{G} \Psi. \tag{10}$$

It establishes an inertial anchor and links the spinor to the local geometry.

4 Comparing K- and G-Boosts

The algebraic similarity between K- and G-boosts hides a fundamental conceptual difference. Both are rotors of the form $R = e^{-\frac{1}{2}\alpha_I \psi}$, but they occupy different algebraic seats.

Aspect	**K-boost (SR)**	**G-boost (Gravitational)**
Symbol	$e^{-\frac{1}{2}\alpha_I \psi_K}$	$e^{-\frac{1}{2}\alpha_I \psi_g(x)}$
Acts on	Spinor components	Local basis / adjoint
Metric reference	Fixed Minkowski	Field-dependent $\not{G}$
Adjoint	Constant β_0	Variable $\not{G} = Q_g \beta_0 Q_g^{-1}$
Physical meaning	Frame change	Gravitational inflow / curvature
Symmetry type	External Lorentz	Internal dynamical field
Invariant	$\Psi^\dagger \beta_0 \Psi$	$\Psi^\dagger \not{G} \Psi$
Anchor	Observer frame	Gravitational medium itself

In summary:

- **K-boosts** are passive, describing relative motion of observers in flat spacetime. They preserve the global metric and the constant adjoint β_0.
- **G-boosts** are active, describing real field deformations of the spacetime medium itself. They redefine the adjoint, the time axis, and hence the local metric structure.

5 Interpretation: Adjoint as the Anchor of Inertia

The adjoint $\not{G}$ is the anchor that connects a spinor to local spacetime. In SR, the adjoint β_0 is fixed and global, making Lorentz transformations purely kinematical. In the gravitational case, the adjoint becomes a field variable, and its evolution defines the local flow of time itself.

Massive particles require this anchor: their left- and right-handed components are coupled through the mass term, which depends on the adjoint. Massless particles, described by Weyl spinors, lack an adjoint and therefore cannot experience a gravitational "boost"—they traverse the curved field without being anchored to it.

Hence, the presence of mass corresponds to the capacity to couple to the gravitational adjoint field. Gravity, in this sense, is the internal manifestation of the inertial structure encoded in $\not{G}(x)$.

6 On the Non-Equivalence of Basis and Component Boosts in the Qg Geometry

In the paper [1], the slashed four-vector

$$\not{P} = \beta^\mu P_\mu$$

was shown to transform covariantly under Lorentz boosts generated by the rotor $\Lambda_D \in \mathrm{Spin}(1,3)_\mathbb{C}$:

$$\not{P}' = \Lambda_D \not{P} \Lambda_D^{-1}. \tag{11}$$

Because of the internal representation property $\Lambda_D \beta^\mu \Lambda_D^{-1} = \Lambda_\mu{}^\nu \beta_\nu$, one could equivalently describe the transformation by *boosting the components* P^μ or by *boosting the basis* β_μ. In special relativity, these are two equivalent viewpoints of the same symmetry: an *active* versus a *passive* description of the Lorentz transformation in a fixed Minkowski background.

Breakdown of equivalence in the gravitational case. Once the gravitational rotor $Q_g(x)$ is introduced, this equivalence ceases to hold physically. The time basis becomes a dynamical field through the adjoint

$$\not{G} = Q_g \, \beta_0 \, Q_g^{-1}, \tag{12}$$

and thus encodes the local gravitational rapidity $\psi_g(x)$. Here the basis β_μ is no longer a fixed background but a field-dependent object; changing it represents a real physical deformation of the local spacetime geometry rather than a coordinate transformation.

In the flat-space limit ($Q_g \to 1$), boosting the basis or the components remains interchangeable. However, in the gravitational regime, $Q_g(x)$ already performs the "boost" of the basis internally. Applying an additional kinematic (K-) boost to the basis would double-count this operation and destroy the clear separation between kinematic and gravitational transformations.

Operational distinction. Within the unified Dirac–Q_g framework, the correct rule is therefore:

Domain	Allowed operation	Forbidden operation
SR sector	Boost either coordinates or basis (choice irrelevant)	–
Qg sector	K-boost coordinates only; basis fixed by $Q_g(x)$	K-boost of the basis/metric

Only the gravitational field rotor $Q_g(x)$ may act on the basis itself, producing the physical deformation of the time axis and the local adjoint $\not{G}$. Lorentz (K-) boosts are restricted to the spinor components within that locally defined frame.

Conceptual implication. The difference captures the shift from an external to an internal geometric picture. In SR, the algebra describes relations between observers in a fixed arena; in the Q_g-framework, the same algebra describes the evolution of the arena itself. The metric and adjoint cease to be kinematic constants and become dynamical variables of the theory. Consequently, K-boosts preserve the local frame, while G-boosts *create* it.

Summary. The algebraic equivalence of "boosting the components" or "boosting the basis" holds only as long as the metric is fixed. Once the adjoint $\not{G}$ becomes field-dependent, boosting the basis becomes a gravitational process and must be reserved exclusively for the Q_g-field dynamics.

7 Origin of the Gravitational Rotor from the Kinematic Boost Freedom

The mathematical freedom present in the Lorentz transformation of biquaternionic (BQ) quantities in the first paper provided the conceptual bridge toward the gravitational rotor field $Q_g(x)$.

There, the slashed four-vector

$$\not{P} = \beta^\mu P_\mu$$

was shown to transform covariantly under a Lorentz (K-) boost generated by the rotor Λ_D:

$$\not{P}' = \Lambda_D \not{P} \Lambda_D^{-1}. \tag{13}$$

From the representation property $\Lambda_D \beta^\mu \Lambda_D^{-1} = \Lambda_\mu{}^\nu \beta_\nu$, it followed that one could equivalently transform either the *components* P^μ or the *basis* β_μ:

$$P'^\mu = \Lambda^\mu{}_\nu P^\nu, \qquad \beta'_\mu = \Lambda_D \beta_\mu \Lambda_D^{-1}.$$

In the special-relativistic domain, these two operations are perfectly equivalent, expressing the same Lorentz symmetry in two dual forms—one active, one passive. This freedom seemed algebraically redundant, yet it turned out to be the seed of a deeper physical structure.

From algebraic duality to physical field. The equivalence between "boosting the components" and "boosting the basis" revealed that the Dirac–BQ algebra naturally supports transformations acting on the *metric generators* β_μ themselves. In flat spacetime this action is purely representational, but it suggested the possibility that the basis could be made to vary dynamically, acquiring spacetime dependence.

Promoting that passive possibility to an active field transformation is precisely what defines the gravitational rotor:

$$\beta_0 \;\longrightarrow\; /G(x) = Q_g(x)\, \beta_0\, Q_g^{-1}(x), \tag{14}$$

where the local rotor $Q_g(x) \in \mathrm{Spin}(1,3)_{\mathbb{C}}$ carries a spatially varying rapidity $\psi_g(x)$. The gravitational field thereby enters the Dirac algebra not as an external metric tensor, but as a *dynamical rotation of the time basis.* The freedom that in special relativity was a matter of convention becomes, in the Q_g-framework, a physical degree of freedom.

Promotion of symmetry to dynamics. In special relativity, boosting the basis or the components leaves the metric invariant. In the Q_g-framework, the same operation on the basis generates curvature and gravitational inflow. The optional duality of the flat-space Lorentz algebra thus becomes the mechanism for embedding gravity inside the algebra itself. Symbolically:

$$\text{(flat SR):} \quad \Lambda_D \beta_\mu \Lambda_D^{-1} \;\equiv\; \Lambda_\mu{}^\nu \beta_\nu, \qquad \text{(gravitational):} \quad \beta_\mu \;\to\; Q_g(x)\, \beta_\mu\, Q_g^{-1}(x).$$

The latter is no longer a symmetry but a genuine field deformation that alters the local adjoint and time direction.

The internal logic of the transition.

Stage	Object transformed	Meaning	Role
BQ / SR theory	$\beta_\mu \to \Lambda_D \beta_\mu \Lambda_D^{-1}$	Passive basis change	Mathematical equivalence
Qg theory	$\beta_0 \to Q_g(x)\, \beta_0\, Q_g^{-1}(x)$	Active local deformation	Physical gravitational field

Thus, the Q_g-boost generalizes the algebraic "basis boost" of SR into a genuine dynamical process. What was a symmetry of representation becomes a source of geometry.

Conceptual significance. This development marks a transition from an external to an internal geometric description:

- In standard relativity, Lorentz covariance relates different observers within a fixed spacetime arena.
- In the Q_g-framework, the same algebraic machinery describes how the local inertial arena itself evolves through space and time.

The latent symmetry of the BQ algebra thus supplies the algebraic *instrument* that allows gravity to emerge from within the Dirac structure rather than being imposed from without.

Summary. The equivalence of basis and component boosts in the BQ Lorentz algebra was not an arbitrary feature: it exposed the algebra's ability to act on its own basis. That latent freedom became the mechanism by which the gravitational rotor $Q_g(x)$ was introduced. Hence, the gravitational boost is the promoted, dynamical realization of what was formerly only a representational option in the flat-space theory.

8 Why Gravity Is Not a Gauge Symmetry in the Qg Framework

In conventional gauge theories, transformations correspond to internal symmetries that leave all observables invariant. They act on redundant degrees of freedom in the field description and represent no change in the physical state. By contrast, in the Q_g-based framework, the gravitational field is not such a symmetry: the rotor field $Q_g(x)$ carries real dynamical content that alters the local geometry itself. The very operation that in special relativity was a gauge-like freedom becomes, here, the *physical substance of gravity.*

1. Gauge transformations versus physical fields. In an ordinary gauge theory, a transformation such as

$$A_\mu \to A'_\mu = A_\mu + \partial_\mu \lambda$$

changes only the potential representation; the field tensor $F_{\mu\nu}$ and all observables remain invariant. Gauge transformations act on the internal fiber over spacetime without changing the spacetime itself.

General relativity often treats coordinate changes as a type of gauge freedom (diffeomorphism invariance), yet even there the metric curvature $R_{\mu\nu\rho\sigma}$ retains physical significance. In the present algebraic construction, the situation is more radical: the gravitational rotor acts directly on the very basis vectors that define spacetime.

2. The active role of the gravitational adjoint. The gravitational field is defined by the adjoint

$$\not{G}(x) = Q_g(x)\, \beta_0\, Q_g^{-1}(x), \tag{15}$$

which makes the local time direction a dynamical entity. When $Q_g(x)$ varies through space and time, its derivative $(\not{\partial} Q_g)Q_g^{-1}$ appears in the covariant operator $\not{G}$ and its commutator curvature

$$F_{\mu\nu} = [\not{D}, \not{D}]$$

acquires energetic content. Different configurations of $Q_g(x)$ therefore correspond to different physical gravitational states. They cannot be removed by a gauge transformation because they *define* the local frame and proper time itself.

3. The transition from gauge freedom to field dynamics. In the biquaternionic (BQ) Lorentz algebra of special relativity, boosting the basis or the components of a slashed quantity

$$\not{P} = \beta^\mu P_\mu$$

was a choice of description. The transformation $\not{P}' = \Lambda_D \not{P} \Lambda_D^{-1}$ could be implemented by acting on either P^μ or β_μ, with no physical distinction. This represented a gauge-like redundancy in the kinematic formulation.

When that basis freedom was promoted to a spacetime-dependent field $Q_g(x)$, it ceased to be a symmetry. The derivatives of $Q_g(x)$ entered the dynamics, and curvature emerged from the commutator of covariant derivatives. The former "gauge parameter" became a *source field* carrying real energy and momentum. Hence, gravity arises precisely from the breaking of the equivalence between component and basis transformations.

4. Conceptual comparison with gauge theory.

Concept	Gauge Theory	Q_g-Dirac Framework
Transformation	Redundancy of description	Real field deformation
Arena	Fixed spacetime manifold	Dynamical adjoint $\not{G}(x)$ defines local frame
Physical effect	None (observables invariant)	Alters proper time, redshift, inertia
Mathematical form	$U(x) \in G$ acts on field components	$Q_g(x) \in \mathrm{Spin}(1,3)_{\mathbb{C}}$ acts on basis itself
Ontological status	Symmetry	Substance (geometry itself)

In gauge theory, the connection field serves to maintain local symmetry. In the Q_g-theory, the connection arises because the local time direction itself is dynamical; symmetry is no longer preserved but continually redefined by the field's evolution.

5. Consequence for gravitational ontology. Once the Lorentz freedom of the basis becomes a spacetime-dependent rotor $Q_g(x)$, the group action that once related equivalent descriptions becomes a generator of real curvature. The field's degrees of freedom are measurable through gravitational redshift, time dilation, and inertial response. Thus, gravity is not the gauge freedom of Lorentz symmetry—it is the *dynamical realization* of that freedom within the Dirac algebra.

Summary. The Q_g-framework provides a natural explanation for why gravity cannot be treated as a gauge symmetry. The rotor field that would serve as a gauge parameter in flat space has been promoted to a physical variable whose evolution reshapes the metric itself. In this sense,

$$\text{Lorentz symmetry} \quad \longrightarrow \quad \text{Lorentz dynamics.}$$

Gravity emerges as the internal activation of what would otherwise be a passive gauge freedom, transforming symmetry into substance.

9 Relation to General Relativity and Extended Power of the Qg Framework

The gravitational rotor framework based on the Dirac–BQ algebra is not equivalent to General Relativity (GR). It reproduces GR as a macroscopic and slow-field limit but extends far beyond it conceptually and dynamically. Where GR treats geometry as an external stage curved by energy and momentum, the Q_g-framework derives geometry and curvature from the internal dynamics of the Dirac adjoint itself. In this sense, GR emerges as the real-valued, coarse-grained limit of a deeper algebraic field theory.

1. General Relativity as external geometry. In Einstein's formulation, the metric tensor $g_{\mu\nu}(x)$ is an independent field on a differentiable manifold. The Einstein equations,

$$G_{\mu\nu} = 8\pi G\, T_{\mu\nu},$$

relate spacetime curvature to the energy–momentum of matter. The geometry is purely classical and external to the quantum fields it hosts. Spinors require an auxiliary tetrad and spin connection to interact with the metric, revealing the dual ontology of GR:

$$\textit{(geometry)} + \textit{(matter)}.$$

The theory links them through equations but does not unify them ontologically.

2. Geometry as an internal rotation of the Dirac algebra. In the Q_g-framework, geometry and matter share a common algebraic origin. The local metric structure is generated internally by the rotor field:

$$\not{G}(x) = Q_g(x)\, \beta_0\, Q_g^{-1}(x), \tag{16}$$

so that the time axis and spatial inflow become internal directions of the Dirac algebra itself. Curvature arises from the field strength of this rotor:

$$F_{\mu\nu} = [\not{D}_\mu, \not{D}_\nu],$$

turning spacetime geometry into the curvature of a complex spin rotor. There is no external manifold with an imposed metric; rather, the Dirac medium curves itself through $Q_g(x)$. Geometry and matter become two conjugate modes of the same underlying field.

3. General Relativity as correspondence limit. At macroscopic scales and for slowly varying $\psi_g(x)$, the rotor field reproduces the geometric structure of GR. From the adjoint $\not{G}(x)$, one can construct a tetrad field

$$e_\mu{}^a(x) \;\propto\; \mathrm{tr}\Big(\beta_\mu\, Q_g\, \beta^a\, Q_g^{-1}\Big)\,,$$

yielding an effective metric $g_{\mu\nu} = e_\mu{}^a e_\nu{}^b \eta_{ab}$. In this limit, the commutator curvature $F_{\mu\nu}$ maps to the Riemann tensor, and the feedback between field energy and adjoint curvature reproduces the Einstein form of gravitational dynamics. Thus, GR is contained within the Q_g-framework as its slow-field, real-valued limit.

4. Why the Q_g-framework is more powerful. Beyond that limit, the theory introduces deeper structure that GR cannot capture.

Aspect	**General Relativity**	**Q_g-Dirac Framework**
Ontology	External metric + matter	Unified algebraic field (geometry = adjoint)
Field variable	$g_{\mu\nu}$ (10 real components)	$Q_g(x) \in \mathrm{Spin}(1,3)_{\mathbb{C}}$ (6 complex parameters)
Field order	Second-order in $g_{\mu\nu}$	First-order in $Q_g(x)$ (Dirac-like)
Coupling to spinors	Introduced via tetrads	Intrinsic in the algebra itself
Curvature source	Energy–momentum $T_{\mu\nu}$	Internal feedback from mass renormalisation
Cosmological term	External constant Λ	Emergent self-stabilisation of ψ_g (dark energy)
Quantum unification	Added externally	Built-in spinor–rotor unity
Nature of space	External manifold	Dynamical medium of the Dirac field

The Q_g-field thus carries additional internal information: complex phase, spinor coherence, and microscopic inertia, all absent from GR. These extra degrees of freedom allow mass renormalisation, cosmic expansion, and vacuum energy to emerge from a single mechanism—the self-regulation of ψ_g.

5. Why this is not merely a reformulation. Because the dynamical variable is $Q_g(x)$ rather than $g_{\mu\nu}$, the theory operates at a deeper level. It unifies the metric and the matter fields within one algebraic flow:

- The spinor phase and complex structure of spacetime are preserved rather than projected out.
- Inertial mass and gravitational energy become conjugate manifestations of the same field mode.
- The cosmological acceleration appears naturally as the asymptotic relaxation of $\psi_g(x)$ to a constant value.

These results lie beyond the explanatory scope of GR, which must import quantum and vacuum effects from outside its geometric formalism.

6. Conceptual synthesis. The two frameworks may be contrasted in their foundational statements:

General Relativity:	"Matter tells spacetime how to curve."
Q_g-Framework:	"The Dirac medium curves itself; matter and geometry are one flow."

Thus, the Einstein field equations are replaced by a single self-consistency relation inside the Dirac algebra:

$$(\text{Curvature of } Q_g) \iff (\text{Renormalisation of spinor energy}).$$

The distinction between source and geometry dissolves; curvature and energy are dual expressions of the same internal dynamics.

7. Summary. The Q_g-framework is not equivalent to GR but more fundamental. It derives spacetime geometry, inertial mass, and gravitation from a single algebraic field, of which GR is the macroscopic, real-valued limit. Where GR imposes curvature externally, the Q_g-field generates it intrinsically through the evolution of its rotor.

$$\text{Einstein's two-sided equation} \longrightarrow \text{One self-consistent Dirac medium.}$$

Gravity becomes an internal mode of the quantum field rather than an external geometry it inhabits.

10 Note to Readers from General Relativity

This work continues a line of reasoning that began with the author's construction of the Dirac and Lorentz structures inside the biquaternionic (BQ) algebra [1]. Readers trained in General Relativity (GR) and its spinor formulations are warmly invited—and simultaneously cautioned—that the ontology adopted here differs in a decisive way from the usual geometric paradigm.

1. Why the first paper is essential. The preceding BQ study does not merely restate known algebra. It rederives the entire Lorentz and Dirac machinery *from within* the BQ algebra, showing that boosts, rotations, and adjoint conjugations can all be represented as internal rotor actions:

$$\not{P}' = \Lambda_D \not{P} \Lambda_D^{-1}.$$

That result, seemingly familiar to any relativist, hides the deeper freedom of acting on either the components P^μ or on the basis elements β_μ. The present paper elevates that mathematical freedom into a new ontology: the gravitational field is identified with the dynamical evolution of that very basis through a local rotor field $Q_g(x)$.

For this reason, the first paper is not optional background. It provides the *grammar* of the language used here—the translation manual between the tensorial GR formulation and the algebraic Dirac–BQ environment. Without it, the subsequent identification of gravity with the adjoint field $\not{G}(x)$ will seem like an arbitrary reinterpretation rather than a natural consequence of the algebra.

2. Invitation to GR specialists. Those fluent in differential geometry will recognize the elements of their own formalism within the BQ setting: the tetrad, spin connection, and metric all appear, but they arise as *internal operators* rather than as externally defined fields. In this sense, the BQ algebra does not discard the tensor calculus of GR; it absorbs it. The payoff is a first-order, fully algebraic description in which matter and geometry are no longer distinct entities but two complementary modes of one Dirac medium.

The conceptual inversion is subtle but profound:

In GR: the metric defines the algebra of spinors.
In the Q_g-framework: the algebra of spinors defines the metric.

This reversal means that even experienced relativists should resist the temptation to presume that the discussion below merely repackages familiar material. The ontology is different: geometry is not imposed upon the algebra; it *emerges from it*.

3. A friendly warning. Readers approaching this work with a GR mindset are encouraged to suspend their geometric reflexes temporarily. The Dirac–BQ algebra is not a representation of spacetime—it *is* spacetime, expressed in algebraic form. The gravitational rotor $Q_g(x)$ is not a gauge connection added to preserve covariance; it is the local generator of curvature itself. Concepts such as "boost," "adjoint," and "metric" retain their algebraic symbols but acquire new meanings when the adjoint becomes a field variable.

4. Purpose of this invitation. This note serves as both an invitation and a warning:

- *Invitation*—because the Q_g-framework unifies the mathematical structures of GR and quantum theory within a single Dirac algebra, offering a simpler and more transparent foundation.
- *Warning*—because the familiar geometric intuition of GR can obscure the novelty of the ontology. The reader who assumes that "this is all known stuff" will miss the essential shift: from curvature as an external geometry to curvature as an internal rotation of the algebra itself.

5. Closing remark. To follow the present work, the reader is urged to consult Ref. [1] not as a historical introduction but as a linguistic prerequisite. Only after mastering the BQ language can one fully appreciate how the gravitational field $Q_g(x)$ arises naturally as the dynamical adjoint of the Dirac algebra, converting the distinction between matter and spacetime into an internal self-consistency of the same medium.

11 Note to Readers from Geometric Algebra and Spacetime Algebra

Specialists familiar with Geometric Algebra (GA) or Spacetime Algebra (STA) will recognize many of the mathematical forms used in this work: rotors acting by conjugation, slashed quantities $\not{P} = \beta_\mu P^\mu$, and the representation of Lorentz transformations as $R \not{P} R^{-1}$. However, such formal familiarity is precisely where misunderstanding is most likely to occur. The present framework shares the syntax of GA/STA but not its ontology. It replaces a representational algebra of geometry with an algebra that *produces* geometry dynamically. The distinction is decisive.

1. Why GA/STA readers will find this familiar. In GA or STA, the following ideas are standard:

- Lorentz transformations represented by rotors R acting as $a' = RaR^{-1}$;
- Real Dirac or Pauli spinors encoded as even multivectors;
- The identification of spacetime geometry with the Clifford algebra of signature $(1, 3)$;
- The use of complexified algebra to represent the Dirac equation and electromagnetic coupling.

For this reason, a GA-trained reader will immediately recognize equations such as

$$\not{P}' = Q_g \not{P} Q_g^{-1}, \qquad \not{G} = Q_g \, \beta_0 \, Q_g^{-1},$$

and may conclude that this is merely STA rewritten in a biquaternionic basis. That conclusion would be incorrect.

2. The fundamental difference. In GA and STA, the spacetime metric is fixed and the algebra is a static representation of its symmetries. Rotors express *kinematic* frame changes within that background. In the present work, this relationship is reversed:

In GA/STA: the algebra describes spacetime.
In the Q_g-framework: the algebra *creates* spacetime.

The rotor field $Q_g(x)$ is not a passive Lorentz transformation acting on a fixed manifold; it is a dynamical field whose spacetime variation generates curvature, energy, and inertia. The adjoint $\not{G}(x) = Q_g \beta_0 Q_g^{-1}$ is not a rotated reference vector but a physically evolving local time direction. This single step—making the basis itself dynamical—constitutes the ontological break with GA/STA.

3. Where GA/STA readers will think "this is all known". The following correspondences illustrate the points of deceptive similarity:

Expression	**GA/STA interpretation**	**Meaning here (in the Q_g-framework)**
$\not{P}' = R\not{P}R^{-1}$	Standard rotor acting on a multivector, purely kinematic.	Algebraic identity promoted to a real field action; $R \to Q_g(x)$ carries curvature.
$\not{G} = Q_g\, \beta_0\, Q_g^{-1}$	Local time axis under Lorentz rotation.	Dynamical adjoint defining gravitational inflow; not a passive frame change.
$Q_g(x) \in \mathrm{Spin}(1,3)_{\mathbb{C}}$	Conventional complex rotor group.	Rotor becomes a spacetime-dependent dynamical variable.
$\not{D} = \not{\partial} + (\not{\partial} Q_g)Q_g^{-1}$	Gauge-covariant derivative preserving local Lorentz symmetry.	Defines the genuine gravitational connection and energy flow of the Dirac medium.
$F_{\mu\nu} = [\not{D}, \not{D}]$	Abstract curvature of a gauge field.	Physical curvature of spacetime itself, measurable through inertia and redshift.
$\psi_g(x)$	Local rapidity or coordinate boost.	Gravitational inflow / expansion field of the Dirac medium.

Every formula familiar from GA reappears, but the interpretation has shifted from representation to generation. Rotors no longer act *on* spacetime; they act *as* spacetime.

4. The core ontological divergence. In GA/STA the algebra encodes a geometry that exists independently of it. In the Q_g-framework, there is no geometry apart from the algebraic field itself. Spacetime curvature arises as the field curvature of $Q_g(x)$:

$$F_{\mu\nu} = [\not{D}_\mu, \not{D}_\nu],$$

and the metric follows from the adjoint $\not{G}(x)$. This inversion turns a mathematical representation into a physical mechanism. GA rotors are passive; Q_g-rotors are generative.

5. Consequences of the shift. The implications are concrete and nontrivial:

- The spacetime metric is not fixed; it evolves with $Q_g(x)$.
- The covariant derivative does not preserve symmetry; it measures the flow of the field itself.

- Curvature carries energy and mass renormalisation; it is not an auxiliary tensor.
- The rapidity field $\psi_g(x)$ links local gravitational inflow, cosmic expansion, and inertial mass.

None of these statements have analogues in GA/STA, because there the rotor field has no dynamics of its own.

6. The limits of GA/STA ontology. GA/STA remains a static formalism. Its spacetime algebra is a closed system of geometric symmetries; it does not provide evolution equations for the geometry itself. Even when GA authors speak of curvature or gauge fields, these live on top of a predetermined spacetime structure. In the Q_g-framework, spacetime structure is an emergent property of the Dirac medium. This means that the Q_g-field contains more information than any fixed Clifford or STA manifold can represent.

7. Factual contrast.

Aspect	**GA / STA**	**Q_g-Dirac Framework**
Role of rotor	Passive symmetry operator acting on fixed space.	Dynamical field generating local curvature and flow.
Spacetime metric	Fixed Minkowski or Riemannian background.	Emergent from the adjoint $\slashed{G}(x)$.
Covariant derivative	Maintains gauge covariance of the algebra.	Defines the true gravitational connection of the Dirac medium.
Curvature	Auxiliary mathematical field strength.	Physical energy–momentum content of the field.
Gravity	External geometric phenomenon.	Internal self-rotation of the algebraic medium.
Ontology	Geometry hosts algebra (representation).	Algebra produces geometry (generation).

8. Plain statement. To readers expert in GA or STA: this work is not a reformulation of your formalism. It uses the same algebraic symbols but with a radically different ontology. Where GA encodes geometry, the present framework generates it. Where GA rotors express Lorentz symmetry, the Q_g-rotor field expresses Lorentz *dynamics*. To assume equivalence is to miss the core result: that gravity and inertia emerge from the self-rotation of the Dirac adjoint medium itself.

9. Summary. The mathematical overlap with GA/STA is extensive, but superficial. The difference lies in ontology and dynamical interpretation. The Q_g-framework promotes what GA treats as kinematic symmetry into the central physical mechanism of spacetime. Rotors cease to represent geometry; they become its cause. Understanding this requires setting aside the assumption that all of this is "already known." It is not. It is the next step beyond GA: the internalisation of geometry into the dynamics of the Dirac field itself.

12 Note to Readers from Bohmian Mechanics and Pilot-Wave Theory

Researchers from the de Broglie–Bohm or pilot-wave tradition will find many ideas in this work immediately resonant. The present framework shares their motivation for an ontologically real quantum field, their search for causal continuity between the microscopic and macroscopic domains, and their conviction that the wavefunction represents a real process in nature. Nevertheless, despite these shared aims, the Q_g-framework differs fundamentally from Bohmian mechanics in ontology, scope, and explanatory power. It replaces the guiding-field dualism of the pilot-wave with a single self-consistent field: the dynamical Dirac medium $Q_g(x)$.

1. Points of immediate resonance. The following parallels will be immediately recognizable to the Bohmian community:

- The gravitational adjoint $\not{G} = Q_g \beta_0 Q_g^{-1}$ acts as a *real guiding field* defining local time and inertial structure, analogous in appearance to Bohm's pilot wave.
- The covariant Dirac-type equation

$$i\hbar(\not{\partial} + \not{V} + \not{G})\Psi - mc\,\Psi = 0$$

  provides a causal, first-order law of evolution similar in spirit to the Bohmian guiding equation.
- The field self-coupling that generates mass and curvature parallels the role of Bohm's quantum potential Q_B as a feedback term modifying classical motion.
- The inflow field $\psi_g(x)$ represents a real spatial and temporal structure of the medium, echoing Bohm's concept of an implicate order or quantum vacuum.

In these respects, the Q_g-framework fulfills many of the philosophical objectives of the Bohmian approach: realism, causality, and unity between wave and matter.

2. Where the resemblance ends. The similarity in form conceals a decisive difference in ontology. In pilot-wave theory the wavefunction and the particles are distinct entities: a real field $\Psi(\mathbf{r}_1, \mathbf{r}_2, \ldots, t)$ evolving on configuration space, and point particles guided by its phase. In the Q_g-framework:

- There are no external particles; all observable structures are excitations or coherent flows of the Dirac medium itself.
- The "guiding field" is not superimposed on space—it *is* the local geometric state of space.
- The quantum potential is not an additional term in a Schrödinger equation but the geometric curvature of $Q_g(x)$, given by

$$F_{\mu\nu} = [\not{D}_\mu, \not{D}_\nu],$$

  where $\not{D}_\mu$ is the slashed covariant derivative of the Dirac medium.

Hence, the relationship between wave and particle, or between matter and geometry, collapses into a single self-interacting field ontology.

3. Likely first interpretations and their correction.

Bohmian expectation	**Interpretation in the Q_g-framework**
Wavefunction guides particles.	There are no separate particles; trajectories are emergent flow lines of the Dirac medium.
Quantum potential modifies Newtonian motion.	The curvature of $Q_g(x)$ generates the same effect geometrically; it is not an added term but intrinsic field energy.
Pilot wave exists on spacetime.	The field $Q_g(x)$ *is* spacetime in its dynamic form; geometry is not pre-given.
Quantum potential is nonlocal influence.	Nonlocality arises from the field's global coherence, not from action-at-a-distance.
Hidden variables restore determinism.	Determinism is structural: the field evolves causally without additional variables.

Thus, what Bohmian mechanics treats as two interacting systems—the wave and the particle—is here a single ontological medium with self-consistent curvature and energy feedback.

4. The geometric completion of the quantum potential. Bohm's quantum potential,

$$Q_B = -\frac{\hbar^2}{2m}\frac{\nabla^2 R}{R},$$

encodes a nonlocal energy without geometric origin. In the present theory, this same role is played by the curvature of the $Q_g(x)$ field:

$$F_{\mu\nu} = [\not{D}_\mu, \not{D}_\nu],$$

which supplies the missing geometry. The mysterious "quantum potential" becomes an expression of the field's internal curvature—the local energy density of the Dirac medium itself. What was previously a supplement to classical mechanics is now recognised as the gravitational self-energy of the quantum field.

5. Conceptual continuity and transformation.

- The Q_g-framework retains Bohm's realism, causality, and continuity of description.
- It removes Bohm's dualism between particles and pilot wave.
- It provides a relativistic, algebraic foundation that unites gravity and quantum mechanics within the same field.
- The guiding field of Bohm becomes the self-rotating spacetime of the Dirac algebra.

In Bohm's own language: the implicate order corresponds to the $Q_g(x)$ field; the explicate order corresponds to its emergent patterns—mass, curvature, and observable motion.

6. How the Bohmian community will likely respond.

Initial impression	**Deeper understanding after study**
A relativistic or field-theoretic extension of the pilot-wave model.	A complete ontological unification where the quantum potential is identical with spacetime curvature.
A geometric reformulation of the de Broglie–Bohm theory.	A replacement of configuration-space ontology by a local, causal field of spacetime itself.
Interesting algebraic formalism related to GA/STA.	A fully dynamical theory in which the Dirac algebra generates its own geometry and gravitational energy.

7. Summary. The Q_g-framework will appear to the Bohmian mechanics community as a familiar but extended version of their causal picture. In fact, it represents a deeper unification in which Bohm's guiding field and spacetime curvature are the same entity. The wavefunction no longer guides particles through space; it *is* the dynamic structure of space. Determinism is preserved, but the dual ontology of matter and wave is dissolved. The "quantum potential" becomes the geometric curvature of the Dirac medium, completing Bohm's vision and embedding it naturally in a relativistic and gravitational context.

13 Note to Other Research Communities

The present framework draws upon and intersects with many established traditions across physics and philosophy. Each community will find elements of familiar form within the Q_g-Dirac theory, yet the underlying ontology differs radically from all of them. This section provides concise orientation notes to help readers from distinct backgrounds understand where their own conceptual expectations may diverge from the intent of this work.

1. Quantum Field Theory and Particle Physics

Researchers trained in quantum field theory (QFT) or particle physics will recognise the appearance of a rotor field $Q_g(x)$ and may interpret it as a new spin connection, gauge potential, or bosonic mediator of gravity. This is a misconception. The field $Q_g(x)$ is not an external gauge field; it is the self-rotating structure of the Dirac medium itself. The gravitational connection is not introduced to preserve covariance but arises from the derivative of the adjoint:

$$\not{G} = (\not{\partial} Q_g) Q_g^{-1}.$$

The theory is first-order and self-contained; there is no independent metric or higher-order curvature term. In contrast to gauge theories, the curvature of $Q_g(x)$ carries real energy—it is not a redundancy. Symmetry and dynamics coincide within the algebra, making quantisation a derived property, not a foundational postulate.

Key distinction: $Q_g(x)$ replaces the external concept of gauge field; it does not add a new one. The Q_g-framework is ontologically prior to both gauge and metric formalisms.

2. Quantum Gravity and Spin-Connection Approaches

The quantum gravity community—especially those working in loop, spin-foam, or Ashtekar-variable formalisms—will note superficial parallels: the appearance of a $\mathrm{Spin}(1,3)$ connection and the use of algebraic curvature $F_{\mu\nu} = [\not{D}_\mu, \not{D}_\nu]$. However, the present approach is continuous rather than discrete and does not quantise spacetime. Quantisation arises internally from the complex phase structure of the Dirac algebra itself. The Q_g-field unifies the gravitational and quantum domains without introducing spin networks, discrete spectra, or external canonical variables.

Key distinction: Gravity in the Q_g-framework is already quantum by construction; there is no separate step of "quantising the metric." Spin networks and connection variables appear only as derived representations of the continuous field $Q_g(x)$.

3. Quantum Foundations and Quantum Information

Researchers in the foundations of quantum mechanics or quantum information theory will encounter an explicitly realist and deterministic field ontology. Probabilistic and informational interpretations of the wavefunction do not apply here. The field $Q_g(x)$ is a physical medium whose internal phase coherence encodes the phenomena usually interpreted as nonlocal correlations or quantum probabilities. There are no "hidden variables" and no measurement postulates: measurement corresponds to geometric interaction between regions of the same field.

Key distinction: The Q_g-framework is ontic, not epistemic. Quantum statistics arise from phase projection within the curved adjoint geometry, not from information-theoretic constraints or observer-dependent collapse.

4. Cosmology and Astrophysics

Astrophysicists and cosmologists will recognise that the field $\psi_g(x)$ reproduces effects normally attributed to dark energy, cosmic expansion, and mass renormalisation. However, it should not be regarded as an additional scalar field or as a modification of the ΛCDM model. The large-scale expansion of the universe is the macroscopic mode of the same $Q_g(x)$ field that generates mass at microscopic scales. No external cosmological constant is imposed: dark energy corresponds to the asymptotic self-stabilisation of $\psi_g(x)$.

Key distinction: Cosmic expansion and mass generation are complementary aspects of one field process. The Q_g-framework replaces both the cosmological constant and scalar-field inflaton models with a single dynamical origin in the Dirac medium.

5. Philosophy of Physics and Ontology

Philosophers of physics will find here a realist, monistic ontology. The Q_g-field is not informational, relational, or observer-dependent. It is a continuous substance in which existence and dynamics coincide. Processes and entities are not distinct categories: every existent is a mode of rotation or curvature within the same algebraic field. The theory is compatible with naturalistic monism but provides a mathematically determinate form of it.

Key distinction: The ontology is realist and dynamical. There is no dualism of geometry and matter, nor an appeal to informational or epistemic constructs. To exist is to rotate.

6. Mathematical Physics and Differential Geometry

Mathematical physicists may attempt to interpret $Q_g(x)$ as a spin connection defined over a Clifford bundle on a manifold. This is not the case. In the present formulation, the algebra defines its own local frame; there is no prior manifold carrying a bundle structure. The Q_g-field and its adjoint $\not{G}(x)$ determine what a local spacetime neighbourhood *is*. The traditional base-space/fiber hierarchy is inverted: the algebra is primary, the manifold secondary.

Key distinction: The theory is algebraic, not fibered. The manifold concept emerges from the algebra's local coherence conditions rather than serving as its foundation.

7. Summary and Prioritisation

Each community will recognise fragments of the Q_g-framework through the lens of its own formalism:

Community	**Typical initial interpretation and corrective orientation**
General Relativity	Interprets Q_g as a tetrad or spin connection; must realise it replaces the metric itself.
Geometric Algebra / STA	Sees familiar rotor algebra; must recognise that rotors here generate geometry, not represent it.
Bohmian Mechanics	Sees a relativistic pilot wave; must grasp that Q_g unites wave and geometry.
Quantum Field Theory	Reads Q_g as a new gauge field; must see it as the dynamical structure of the Dirac adjoint.
Quantum Gravity	Sees a spin-connection analogue; must note that quantisation is intrinsic, not imposed.
Cosmology	Sees a scalar-field cosmology; must note that expansion and mass are dual field modes.
Mathematical Physics	Sees a Clifford-bundle formalism; must realise the algebra defines its own base manifold.
Philosophy of Physics	Sees process or relational metaphysics; must understand that the ontology is realist and algebraic.

Overall guidance: Each discipline will find in the Q_g-framework familiar structures—gauge fields, spin connections, pilot waves, or tetrads—but all must avoid reinterpreting them within their existing ontologies. The field $Q_g(x)$ is neither a representation of geometry nor a coupling to it: it is the self-rotating substrate from which geometry, matter, and dynamics emerge together. This unification requires a conceptual shift rather than a technical extension of current theories.

14 From Second- to First-Derivative Dynamics

The central structural move of this framework is the replacement of second-derivative (Einstein/Klein–Gordon–type) dynamics by a first-derivative (Dirac–type) law written entirely inside the Dirac–BQ algebra. This section states the transition precisely and traces its consequences.

14.1 Background: second vs. first order

Classical relativistic field theories are typically second order in derivatives:

- Einstein gravity: curvature tensors $\sim \partial^2 g_{\mu\nu}$.
- Klein–Gordon: $(\Box + m^2)\phi = 0$.
- Yang–Mills/Maxwell: $\partial_\mu F^{\mu\nu} = J^\nu$ with $F_{\mu\nu} = \partial_{[\mu} A_{\nu]}$.

The Dirac equation is first order:

$$i\hbar\,\beta^\mu\,\partial_\mu \Psi - mc\,\Psi = 0,$$

where the β-matrices serve as algebraic "square roots" of the metric, linearising relativistic dynamics.

14.2 The transition inside the Qg framework

The gravitational sector is written in first-order form by promoting the local rotor $Q_g(x) \in \mathrm{Spin}(1,3)_{\mathbb{C}}$ to the fundamental field:

$$\not{G}(x) = Q_g(x)\,\beta_0\,Q_g^{-1}(x), \tag{17}$$

$$\not{\mathcal{G}}(x) = \not{\partial} + (\not{\partial} Q_g)Q_g^{-1}, \tag{18}$$

and by defining curvature as a *commutator of first derivatives*:

$$F_{\mu\nu} := [\not{D}_\mu, \not{D}_\nu], \qquad \not{D} := \not{\partial} + (\not{\partial} Q_g)Q_g^{-1}. \tag{19}$$

Geometry (the local time axis and lapse/shift) is encoded in $\not{G}$; gravitational "connection" is $(\not{\partial} Q_g)Q_g^{-1}$. No second derivative of a metric is fundamental; those appear only as derived quantities from Q_g.

14.3 Conceptual meaning of the shift

Feature	**Second order (GR/KG)**	**First order (Q_g-Dirac)**
Primary variable	$g_{\mu\nu}$ or ϕ	Rotor $Q_g(x)$
Field operator	$\partial^2 g$, $\Box\phi$	$\not{D} Q_g = (\not{\partial} Q_g)Q_g^{-1}$
Physical content	Acceleration/curvature	Rotation/flow of adjoint
Source of inertia	External $T_{\mu\nu}$	Self-coupling of $\not{G}$
Energy form	Quadratic in ∂	Bilinear spinor form
Geometry	External metric tensor	Emergent from $\not{G} = Q_g\beta_0 Q_g^{-1}$
Evolution law	Second order in time	First order in proper time

In words: we pass from "geometry as second-derivative curvature acting on matter" to "geometry as first-derivative rotation constituting matter."

14.4 Field equations and conserved structures

The Dirac Lagrangian enhanced by Q_g reads

$$\mathcal{L}_{\text{Dirac}} = \frac{i\hbar}{2}\Big(\Psi^\dagger \bar{G}\not{G}\Psi - (\not{G}\Psi)^\dagger \bar{G}\Psi\Big) - mc\,\Psi^\dagger \bar{G}\Psi. \tag{20}$$

Variation gives a first-order covariant equation

$$i\hbar\,(\not{\partial} + \not{\Gamma} + \not{G})\Psi - mc\,\Psi = 0, \qquad \not{\Gamma} = \tfrac{1}{2}\,\bar{G}^{-1}(\not{\partial}\bar{G}), \tag{21}$$

and a conserved current $J = \Psi^\dagger \bar{G}\beta\Psi$ with $\not{\partial}J = 0$ on-shell. Gravitational curvature is $F_{\mu\nu} = [\not{D}_\mu, \not{D}_\nu]$, built entirely from first derivatives of Q_g.

14.5 Physical consequences

(a) Local linearity and causal propagation. First-order evolution transports phases along characteristic (null/timelike) directions without introducing second-order hyperbolic artefacts. Causality is implemented algebraically by β^μ.

(b) Unification of spin and curvature. Because $Q_g(x) \in \mathrm{Spin}(1,3)_\mathbb{C}$, spin and geometry share the same connection. No separate tetrad/spin-connection split is needed.

(c) Transparent energy balance. Bilinear (first-order) Lagrangians yield natural Noether currents and avoid pseudo-tensors. The adjoint $\bar{G}$ anchors Hermiticity and energy positivity locally.

(d) Intrinsic quantisation. Quantisation appears as topological/phase properties of rotor evolution (e.g. 2π cycles), not as an externally imposed operator calculus.

(e) Geometric self-consistency. Curvature as a commutator $[\not{D}, \not{D}]$ builds in Bianchi-type identities at the algebraic level and prevents overdetermination characteristic of purely tensorial second-order closures.

(f) Cosmological interpretation. A large-scale, slowly varying rapidity $\psi_g(x)$ produces expansion as a kinematic relaxation (first-derivative flow of the time basis), not as a second-derivative "explosion" of a scale factor.

14.6 Compact comparative summary

Layer	**Second derivative**	**First derivative**
Mathematical type	Second-order PDEs	First-order PDEs in algebra
Fundamental object	$g_{\mu\nu}$, ϕ	Q_g, $\bar{G}$
Curvature origin	$\partial^2 g$	$[\not{D}_\mu, \not{D}_\nu]$
Dynamics picture	Force/acceleration	Rotation/phase flow
Energy source	$T_{\mu\nu}$ external	Self-interaction of Q_g
Quantisation	Imposed	Emergent from rotor topology
Ontology	Objects in curved space	Space as rotating object

14.7 One-line essence

The move from the second-derivative description of Einstein-type curvature to the first-derivative formulation of the Dirac–Q_g field transforms gravity from an external geometry acting upon matter into an internal rotation constituting matter itself. It replaces acceleration by rotation, curvature by commutator, and the metric by the evolving adjoint $\not{G}(x)$; a shift from ***geometry of motion*** *to* ***motion as geometry*** *within the self-consistent dynamics of the Dirac–BQ algebra.*

15 Discussion: Foundational Simplification

The transition from second- to first-derivative dynamics presented here represents an attempt to simplify the formal structure of gravitational and quantum theory. Rather than introducing additional entities or dimensions, the formulation seeks to describe geometry and matter through a single algebraic field. While the mathematical implications appear far-reaching, the results should be viewed as exploratory and open to further investigation.

15.1 Historical and structural context

Historically, reductions in the differential order of fundamental equations have accompanied major conceptual shifts in physics:

- In moving from Newtonian mechanics to general relativity, acceleration was replaced by geodesic motion, absorbing forces into the curvature of spacetime.
- The Dirac equation replaced the second-order Klein–Gordon form by a first-order operator, introducing intrinsic spin and local causality.
- The present construction continues this tendency by expressing curvature itself as a first-order rotor dynamics, in which the rotation of the local time axis replaces curvature of an external manifold.

Each step reduces the mathematical order of differentiation while extending the interpretive reach of the theory.

15.2 Structural simplifications in the Qg formulation

Metric as algebraic quantity. The spacetime metric is represented as a bilinear form within the algebra,

$$g_{\mu\nu} \sim \mathrm{tr}(\beta_\mu \not{G} \beta_\nu \not{G}),$$

and is therefore not treated as an independent field but as a property of the adjoint $\not{G} = Q_g \beta_0 Q_g^{-1}$.

Connection and curvature from differentiation. The connection $(\not{\partial} Q_g)Q_g^{-1}$ and the curvature $F_{\mu\nu} = [\not{D}_\mu, \not{D}_\nu]$ arise directly by differentiation and commutation. Standard geometric identities follow algebraically without additional assumptions.

Unified treatment of spin and curvature. Because the field $Q_g(x)$ lies in $\mathrm{Spin}(1,3)_{\mathbb{C}}$, spin and geometry share the same mathematical structure. Local rotational dynamics and large-scale curvature are described by the same first-order operator.

Quantisation as a geometric property. Quantisation appears as a topological aspect of the rotor's phase structure; closed cycles of Q_g correspond to 2π rotations. No separate quantisation rule is required at the level of the field equation.

Energy conservation as an internal identity. With first-order dynamics, conservation of the current

$$J = \Psi^\dagger \not{G} \Psi, \qquad \not{\partial} J = 0,$$

follows directly from the algebraic structure of the equation rather than from an imposed external constraint.

Continuity across scales. The same field equation governs microscopic and cosmological behaviour. At short scales it describes mass, spin, and inertia; at large scales the slow variation of $\psi_g(x)$ appears as cosmic expansion or dark-energy behaviour.

15.3 Relation to Quantum Chromodynamics and the Standard Model

The Q_g-Dirac framework is intended as a structural reformulation of spacetime and gravitation, not as a replacement for the established gauge theories of particle physics. Quantum chromodynamics (QCD) and the electroweak sector remain valid and essential descriptions of the internal symmetries of matter fields. The present formulation concerns the external, geometric degrees of freedom—the field properties of space and time themselves—and therefore complements rather than supersedes the Standard Model. If future work succeeds in connecting the colour and flavour symmetries of QCD to specific internal modes of the Q_g-field, such a link would represent an extension, not a contradiction, of current theory. At the present stage, Q_g should be regarded as providing the gravitational and geometric background in which QCD and electroweak processes occur.

15.4 Conceptual implications

This first-derivative approach suggests that several long-standing dualities in physical theory may have a common origin. Geometry and matter, kinematics and dynamics, and microscopic and cosmological descriptions appear as complementary aspects of the same field. In this view, curvature and rotation are not distinct phenomena but two forms of algebraic self-consistency within the Dirac medium. The proposal does not claim finality; it identifies a structural pathway by which these domains might be expressed more economically.

15.5 Comparative overview

Paradigm	**Underlying structure**	**Typical interpretation of dynamics**
Classical mechanics	Forces acting on particles	Acceleration of coordinates
General relativity	Curved spacetime metric	Geodesic motion in a curved manifold
Quantum mechanics	Phase evolution of wavefunction	Probability amplitude in fixed space
Q_g-Dirac formulation	Rotation of a Dirac medium	Geometry, mass, and motion as coupled modes

15.6 Further perspective

At the current stage the Q_g-Dirac framework should be regarded as a unifying reformulation rather than a completed theory. Its apparent simplicity and algebraic closure invite further work to test whether the first-order dynamics can reproduce the empirical content of general relativity and quantum field theory. Future analysis will need to determine the extent to which this algebraic formulation can yield quantitative agreement with established results and predict new phenomena.

15.7 Summary statement

The first-derivative formulation presented here may provide a simpler and more integrated representation of physical structure: one in which geometry, matter, and quantisation appear as interdependent aspects of a single Dirac medium. It complements existing quantum field theories, including QCD and the electroweak model, by addressing the underlying geometry in which they operate. The interpretation remains tentative but highlights a possible route toward reducing the conceptual complexity of foundational physics.

16 Conclusion

The analysis presented here extends the Dirac–BQ formalism by introducing the gravitational rotor field $Q_g(x)$ and exploring its implications for the structure of relativistic dynamics. By distinguishing between the kinematic (special-relativistic) boost acting on spinor components and the gravitational boost acting on the local basis through the adjoint $\not{G} = Q_g \beta_0 Q_g^{-1}$, the framework reinterprets curvature as a process internal to the Dirac algebra. The resulting Lagrangian is first order in derivatives, allowing gravitational connection, curvature, and conserved current to be expressed within a single algebraic environment.

In this picture, geometry and matter are complementary aspects of one field. Spin, inertia, and curvature share a common origin in the first-order dynamics of the rotor, and general relativity appears as the macroscopic, slow-field limit of the same algebraic structure. The approach does not replace existing quantum field theories but complements them by addressing the geometric background in which gauge interactions occur. Quantum chromodynamics and the electroweak model remain valid descriptions of internal symmetries, while the Q_g-field concerns the external, space–time degrees of freedom.

Several conceptual advantages follow from the first-derivative formulation. The metric becomes an algebraic property of the adjoint rather than an independent tensor; energy and current conservation emerge as internal identities; and quantisation appears as a topological feature of the rotor field rather than as a separate quantisation rule. At the same time, the construction remains open: the empirical adequacy of the model and its relation to existing gravitational phenomenology require further analysis.

The results suggest that a continuous Dirac medium may underlie both microscopic and cosmological phenomena, with the same field dynamics generating mass at small scales and expansion at large scales. Whether this structural unification can be developed into a predictive physical theory remains to be seen. The present work should therefore be regarded as a step toward a more compact and internally coherent description of gravitation and quantum structure, formulated entirely within the Dirac algebra. *The Dirac–Qg field thus offers a coherent algebraic route toward describing gravitational and quantum structure within one continuous first-order dynamics, awaiting further quantitative development and empirical evaluation.*

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