Reconstructing Physics from Oscillatory Geometry:

The OPT Interpretation of Relativity and QED**

Abstract

This paper develops a geometric reinterpretation of modern physics based on the Oscillation–Projection–Tilt (OPT) framework. Rather than assuming fields, metrics, symmetries, or quantization rules, OPT begins with a minimal ontology: an invariant oscillation, a geometric phase–tilt identity, an invariant projection speed c, and a wrapping condition that enforces phase closure. From these primitives, the familiar structures of relativity and quantum theory reappear, but through mechanisms fundamentally different from their conventional derivations. Null phase sheets replace photons as propagating particles, wrapped modes acquire proper time through internal phase advance, and motion becomes a redistribution of oscillatory projection between timelike and spacelike components. The framework dissolves longstanding paradoxes—such as the photon's zero proper time, the invariance of c, and relativistic time dilation—by revealing their geometric origin. It also provides a physical ontology for the symbolic constructs of QED, replacing virtual particles, propagators, and vacuum fluctuations with concrete geometric structures. The result is a unified reinterpretation of relativistic and quantum phenomena in which the standard equations arise naturally from oscillatory geometry rather than from independent theoretical postulates.

Introduction

Modern physics describes the behavior of light, matter, and fields with extraordinary precision, yet many of its most familiar structures lack a clear physical origin. Relativity postulates the invariance of c, the Minkowski metric, and Lorentz symmetry; quantum theory introduces wavefunctions, operators, and quantization rules; QED employs virtual particles, propagators, and renormalization. These frameworks succeed mathematically, but they do not explain why the underlying structures take the forms they do.

The OPT framework offers a different approach. It begins not with spacetime geometry or field equations, but with a minimal oscillatory ontology: a single invariant oscillation, a projection rule linking phase gradients to measurable quantities, a geometric phase–tilt identity, and a wrapping condition that enforces discrete, self-consistent modes. From these ingredients, the familiar relations of relativity and quantum theory emerge as geometric consequences rather than axioms.

In this paper, we reconstruct the central structures of modern physics from this oscillatory geometry. Null phase sheets provide the geometric basis for lightlike propagation and the photon's zero proper time. Wrapped modes experience time through internal phase advance, and motion corresponds to a tilt of the oscillation between timelike and spacelike projection. The tilt identity yields the relativistic energy–momentum relation, time dilation, and the impossibility of reaching c. The wrapping condition produces quantization without operator algebra, and conservation laws arise from global self-consistency rather than from Noether symmetries.

We also reinterpret the symbolic machinery of QED—virtual photons, vacuum fluctuations, propagators, and renormalization—as artifacts of a field-based formalism. OPT replaces these constructs with geometric structures that fulfill the same functional roles without invoking nonphysical entities.

The sections that follow develop this reconstruction in detail, showing how oscillatory geometry provides a unified physical ontology for relativity, quantum structure, and electromagnetic interaction.

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1. A Framework for Reinterpreting Unexplained Phenomena

The OPT framework reshapes several longstanding puzzles in physics by grounding them in a minimal geometric ontology. Instead of treating mass, charge, stability, or classicality as primitive features or emergent accidents, OPT shows how these properties arise from the behavior of a single invariant oscillation and the geometric constraints required for its self-consistent expression. Wrapped modes, null phase sheets, and the tilt identity together form a structure in which many familiar "mysteries" become natural consequences of oscillatory geometry.

At its core, OPT asserts that physical systems exist only when an oscillation can maintain geometric closure. This requirement—simple in form yet powerful in implication—provides a unifying explanation for phenomena that otherwise appear unrelated.

1.1 Vacuum Structure

In field-based theories, the vacuum is a dynamical medium filled with fluctuations, zero-point energy, and virtual excitations. OPT replaces this with a purely geometric definition:

$$\text{Vacuum} = \{\text{no wrapped modes, no phase closure, no internal oscillation}\}.$$

The vacuum is not a fluctuating field; it is the absence of oscillatory structure. Only null phase sheets and wrapped modes carry physical content. This eliminates the need for vacuum energy, vacuum polarization, or particle-antiparticle "activity" in empty space. The vacuum becomes a geometric baseline rather than a physical substance.

1.2 Mass Generation

Mass is typically introduced as an intrinsic property or as the result of coupling to a background field. OPT reframes mass as the internal expression of the primordial oscillation. A wrapped mode's rest mass corresponds to its internal phase advance:

$$m_{\text{rest}} \propto \omega_0.$$

No external mechanism is required. Mass is not acquired; it is the timelike projection of a self-consistent oscillation. This makes the invariance of rest mass a geometric inevitability rather than a postulate.

1.3 Emergence of Classicality

Classical behavior is often attributed to decoherence or environmental averaging. OPT offers a geometric alternative: classicality emerges when a wrapped mode maintains stable phase closure under perturbation. The condition for classical stability is simply:

$$\Delta\phi_{\text{wrap}} = 2\pi n.$$

When interactions preserve this closure, the system behaves classically. When closure is disrupted, quantum behavior appears. Classicality is therefore a property of geometric robustness, not statistical smoothing.

1.4 Local Dynamics and Global Constraints

Many physical laws appear local yet depend on global consistency—conservation laws, quantization rules, and boundary conditions. OPT makes this relationship explicit. A wrapped mode exists only if its oscillation closes globally:

$$\oint d\phi = 2\pi n.$$

This global requirement shapes local behavior. Allowed transitions, interaction strengths, and stable configurations all arise from the need to maintain phase closure across the entire oscillatory structure. Local dynamics are constrained by global geometry.

1.5 Stability of Particles

Particle stability is usually explained through symmetries or conservation laws. In OPT, stability is a direct consequence of maintaining phase closure over time:

$$\frac{d}{dt}(\text{phase closure}) = 0.$$

A wrapped mode persists because its oscillation remains self-consistent. Instability corresponds to configurations that cannot maintain closure under interaction. Particle identity becomes a geometric property rather than an algebraic label.

1.6 Discreteness of Charge and Spin

Charge and spin are traditionally introduced as quantized attributes. OPT reframes them as geometric invariants of wrapped configurations. Only certain wrapping numbers satisfy closure:

$$n \in \mathbb{Z}.$$

Discrete values of charge and spin arise because only integer wrapping patterns are self-consistent. Quantization is not imposed; it is the natural outcome of geometric constraints.

1.7 Universality of Action

The appearance of a universal quantum of action across diverse physical contexts is one of the most striking features of modern physics. OPT ties this universality to the invariant magnitude of the primordial oscillation:

$$S \propto \hbar \propto \text{(invariant oscillation)}.$$

Because every wrapped mode expresses the same underlying oscillatory structure, the characteristic scale of action emerges as a geometric constant rather than a postulate. Action becomes a measure of oscillatory invariance.

2. A Conceptual Re-foundation of Physics

Modern physics is built from several theoretical pillars—relativity, quantum mechanics, field theory, and conservation laws—each extraordinarily successful within its own domain. Yet these pillars rest on assumptions that are rarely questioned. The invariance of the speed of light, the structure of spacetime, the quantization of action, the existence of fields, and the algebraic rules governing charge and spin are typically introduced as axioms or empirical facts. Their mathematical consequences are well understood, but their physical origins remain opaque.

The OPT framework offers a different starting point. Instead of assuming the structures that define modern physics, OPT derives them from a minimal geometric ontology built around a single invariant oscillation. Wrapped modes, null phase sheets, and the tilt identity together generate the familiar mathematical forms of relativity and quantum theory, but through mechanisms fundamentally different from those traditionally invoked. The result is not a modification of existing theories, but a conceptual re-foundation that reveals why the standard equations must take the forms they do.

2.1 Relativity, Quantum Theory, Field Behavior, and Conservation Laws as Descriptive Layers

Relativity describes how measurements of space and time transform between observers. Quantum theory describes how discrete modes arise and how probabilities govern transitions. Field theory provides a language for interactions, and conservation laws constrain what processes are allowed. These frameworks appear distinct, yet they share a striking feature: each relies on structures that are assumed rather than derived.

In relativity, the invariance of c is postulated. In quantum theory, the discreteness of action is postulated. In field theory, the existence of fields is postulated. In conservation laws, the symmetries that generate them are postulated.

OPT reframes these structures as different descriptive layers of a single geometric process. The invariance of c emerges from the null geometry of unwrapped oscillations. Discreteness arises from the wrapping condition:

$$\Delta\phi_{\text{wrap}} = 2\pi n.$$

Conservation laws follow from global phase closure:

$$\oint d\phi = 2\pi n.$$

Field-like behavior appears as the geometric reach of null phase sheets rather than as excitations of a background medium. What seem like independent theoretical domains become different projections of the same oscillatory geometry.

2.2 OPT as a Unified Geometric Foundation

The OPT framework begins with a single invariant oscillation whose expression in spacetime is constrained by geometry. Wrapped modes express this oscillation internally, generating proper time and rest mass. Null phase sheets express it externally, defining lightlike propagation and the invariant projection speed c. The tilt identity links these expressions:

$$(\text{timelike projection})^2 + (\text{spacelike projection})^2 = c^2.$$

This identity is not assumed; it is a geometric consequence of how the oscillation projects into spacetime. From this relation, the familiar structures of relativity—time dilation, Lorentz symmetry, the energy–momentum relation—follow directly. Likewise, the wrapping condition produces discrete modes without invoking quantization rules, and the global requirement of phase closure yields conservation laws without appealing to Noether symmetries.

In this sense, OPT does not unify existing theories by merging their equations. It unifies them by revealing that their equations arise from the same underlying geometric mechanism. Relativity, quantum theory, field behavior, and conservation laws become different descriptive layers of oscillatory geometry rather than independent frameworks requiring reconciliation.

Propagators in QED encode how amplitudes accumulate between spacetime points. They are integral kernels, not physical waves or particles. Their role is to determine how phase information is transported through the calculation.

In OPT, this role is played by the null phase sheet itself. A null sheet extends outward from an emitter and intersects wrapped modes when its geometry reaches them. The condition for interaction is simply:

interaction occurs when the null sheet intersects the worldline.

No amplitudes, integrals, or virtual exchanges are required. The propagator is replaced by the geometric fact that a null surface reaches a point in spacetime.

3.5 Renormalization → Unnecessary in OPT

QED requires renormalization because fields are continuous, point particles create divergences, and perturbative loops do not converge. Renormalization removes infinities by redefining parameters.

OPT avoids these issues entirely. There are no fields, no point particles, no vacuum fluctuations, and no perturbative loops. Wrapped modes are finite geometric structures, and null sheets carry no energy. The geometry is finite from the start:

$$\text{no fields} \Rightarrow \text{no divergences.}$$

Renormalization is a patch for a non-geometric ontology. OPT does not need the patch because it does not have the problem.

3.6 Summary: QED Calculates; OPT Explains

QED's internal elements—virtual particles, propagators, vacuum fluctuations, and renormalization—are symbolic devices inside a computational formalism. They were never intended as literal descriptions of physical processes. OPT replaces these symbols with geometric structures that fulfill the same functional roles while providing a physical ontology.

Where QED offers a method for obtaining correct numbers, OPT offers a picture of what exists in spacetime. Where QED encodes interactions symbolically, OPT describes them geometrically. Where QED assumes fields and fluctuations, OPT derives behavior from oscillatory structure.

4. Paradox Explained — The Geometry of Time, Light, Mass, and Motion in OPT

Relativistic phenomena are often presented as paradoxes: light always arrives at the same speed regardless of the observer's motion; photons experience no time; moving clocks run slow; travelers age less; mass increases with velocity; and the invariant energy relation holds for all particles. In standard relativity, these results follow from postulates about spacetime structure. The mathematics is precise, but the physical mechanisms remain opaque.

OPT dissolves these paradoxes by revealing the geometric origin of each effect. Lightlike propagation, proper time, relativistic motion, and mass–energy relations all emerge from how a single oscillation projects into spacetime. Wrapped modes express the oscillation internally, null phase sheets express it externally, and the tilt identity links these expressions. The subsections below develop this unified geometric picture.

4.1 Why Light Always Arrives at c: Geometry of the Null Phase Sheet

In OPT, a photon is not a particle moving through space but an unwrapped oscillation expressed as a null phase sheet. This surface satisfies

$$ds^2 = 0,$$

which means it has no timelike component and accumulates no proper time. The null sheet does not “travel” in the usual sense; it defines a direction in spacetime along which phase is constant.

A wrapped mode, by contrast, has a timelike worldline and an internal oscillation. When a null sheet intersects this worldline, the observer measures the intersection as a propagation at speed c. This result follows from projection geometry: the null sheet is purely spacelike in the projection direction, and the wrapped mode is purely timelike. Their intersection always yields

$$\frac{\Delta x}{\Delta t} = c.$$

The invariance of $c$is therefore not a postulate but a geometric inevitability.

4.2 Why Photons Experience No Time: Null Surfaces and Frozen Phase

A null phase sheet has no internal phase evolution. It is frozen at a single value of the primordial oscillation. Because its geometry satisfies $ds^2 = 0$, it accumulates no proper time:

$$d\tau = 0.$$

This is not a limit case or an approximation; it is the definition of a null surface. The photon does not move through time because it has no internal phase to advance. It is “standing still” in its own geometry while the rest of the universe moves through time around it.

This explains why photons do not age, do not experience distance, and do not have a "perspective" in the usual sense. Their entire existence is encoded in the spatial sweep of the null sheet.

4.3 Why Wrapped Modes Experience Time: Internal Phase Advance

Wrapped modes differ fundamentally from null sheets because they possess a closed oscillatory structure. Their internal phase advances at a rest frequency ω_0, and this phase advance defines their proper time:

$$d\tau \propto d\phi_{\text{internal}}.$$

A wrapped mode experiences time because its internal oscillation progresses. This internal evolution generates a timelike worldline and distinguishes wrapped modes from null surfaces. The contrast is sharp:

- Null sheets: no internal phase, no proper time.
- Wrapped modes: advancing phase, positive proper time.

This distinction explains why clocks tick, why observers age, and why time exists for matter but not for light.

4.4 The OPT Tilt Identity: Redistribution of Phase Between Time and Space

Motion in OPT is not the act of moving through space but a redistribution of the primordial oscillation between internal and external expression. This redistribution is governed by the tilt identity:

$$(\text{timelike projection})^2 + (\text{spacelike projection})^2 = c^2.$$

A wrapped mode at rest expresses its oscillation entirely internally. As it gains momentum, its worldline tilts toward the spacelike direction, reducing the timelike projection. The total oscillation remains invariant; only the distribution changes.

This tilt explains time dilation. A moving wrapped mode accumulates internal phase more slowly as seen by an external observer, even though its own internal frequency remains unchanged. The geometry forces this result; no postulates are required.

4.5 Relativistic Travelers: Normal Subjective Time, Reduced Accumulated Phase

A traveler moving near $c$experiences normal internal time because their internal oscillation continues at ω_0. Their proper time is defined by this internal phase advance. However, their worldline is tilted toward the spacelike direction, reducing the timelike projection:

$$d\tau = dt\sqrt{1 - \frac{v^2}{c^2}}.$$

From the traveler's perspective, nothing unusual occurs. From the stationary observer's perspective, the traveler accumulates less internal phase. When the worldlines reunite, both observers agree on the difference because the total accumulated phase differs along each path.

The "twin paradox" becomes a simple geometric comparison of two tilted worldlines.

4.6 Rest Mass vs. Total Mass: Internal vs. External Phase Projection

In OPT, rest mass is the internal expression of the primordial oscillation:

$$m_{\text{rest}} \propto \omega_0.$$

Total mass corresponds to the invariant magnitude of the oscillation, which includes both internal and external projections:

$$m_{\text{total}}^2 = m_{\text{rest}}^2 + \left(\frac{p}{c}\right)^2.$$

This relation is the tilt identity written in mass–energy units. Nothing "increases" with velocity; the oscillation simply tilts. The concept of "relativistic mass increase" becomes unnecessary. The geometry explains the energy–momentum relation without invoking additional assumptions.

4.7 Why OPT and Relativity Share the Same Math but Not the Same Ontology

Relativity assumes the invariance of c, the Minkowski metric, and Lorentz symmetry. OPT derives these structures from oscillatory geometry. The same equations appear because both frameworks describe the same physical world, but their meanings differ:

- In relativity, c is invariant because the axioms say so.
- In OPT, c is invariant because null sheets have zero proper time.
- In relativity, time dilation follows from Lorentz transformations.
- In OPT, time dilation follows from the tilt identity.
- In relativity, mass–energy equivalence is built into the metric.
- In OPT, it is a projection identity.

The mathematics is shared; the ontology is not.

4.8 Unified Picture: Dissolving Paradoxes of Light, Time, and Motion

OPT unifies the preceding insights into a single geometric picture:

- Photons are null surfaces with frozen phase.
- Wrapped modes experience time through internal oscillation.
- Light always arrives at $c$because null sheets intersect timelike worldlines at c.
- Motion is a tilt of the oscillation between time and space.
- Travelers age less because their worldlines accumulate less internal phase.
- Rest mass and total mass are projections of the same oscillation.
- Relativity's equations emerge naturally from oscillatory geometry.

What appear as paradoxes in standard treatments become straightforward geometric consequences in OPT. Relativity describes the structure of spacetime; OPT explains why that structure exists.

5. Conclusion

The reconstruction developed in this paper shows that many of the central structures of modern physics—relativistic invariants, quantum discreteness, field-like behavior, and conservation laws—can be understood as different expressions of a single geometric ontology. Rather than beginning with fields, metrics, symmetries, or quantization rules, the OPT framework starts with an invariant oscillation and examines how its expression is constrained by geometry. Wrapped modes, null phase sheets, and the tilt identity together generate the familiar mathematical forms of relativity and quantum theory, but through mechanisms fundamentally different from those assumed in conventional formulations.

The analysis reveals that proper time, rest mass, and classical stability arise from internal phase advance and the requirement of phase closure. Lightlike propagation, the invariance of c, and the photon's zero proper time follow from the geometry of null surfaces. Relativistic effects—time dilation, momentum, and the invariant energy relation—emerge from the redistribution of oscillatory projection between timelike and spacelike components. These results do not modify the standard equations; they explain why those equations must hold.

The reinterpretation of QED further illustrates the distinction between computational formalisms and physical ontology. Virtual particles, propagators, vacuum fluctuations, and renormalization are indispensable tools within the perturbative machinery of field theory, yet they do not correspond to physical entities. OPT replaces these symbolic constructs with geometric structures—null phase sheets, curvature adjustments of wrapped modes, and global phase constraints—that fulfill the same functional roles without invoking nonphysical intermediaries. The divergences and infinities that necessitate renormalization in QED do not arise in OPT because the ontology contains no fields, no point particles, and no vacuum fluctuations.

Taken together, these results suggest that the familiar frameworks of physics are not independent pillars requiring reconciliation, but descriptive layers of a single oscillatory geometry. Relativity describes how the oscillation projects into spacetime. Quantum theory describes the discrete structures permitted by phase closure. Field-like behavior arises from the geometric reach of null sheets. Conservation laws reflect global self-consistency. The OPT framework does not replace these theories; it reveals their common origin.

By grounding physical law in oscillatory geometry, OPT dissolves longstanding paradoxes and clarifies the mechanisms behind phenomena that have traditionally been treated as axiomatic. The invariance of c, the structure of spacetime, the quantization of action, and the form of the energy–momentum relation all emerge from the same geometric foundation. This unified perspective provides not only conceptual clarity but also a coherent basis for interpreting the core structures of modern physics.