Axiom of Geometric Invariance: Mass as Residual Vacuum Holonomy

Abstract

We propose a foundational axiom replacing invariant mass with a topological residual angle of the vacuum. In this formulation, particles are not fundamental objects but stable geometric invariants of non-harmonic curvature. Observable mass emerges as vacuum stiffness, and detection corresponds to holonomy dissipation.

1 Axiom

Axiom (Geometric Invariance). There exists no fundamental mass parameter m. Every stable physical excitation is characterized by a residual geometric angle γ, defined as the Berry holonomy over a closed contour $\mathcal{C}$:

$$\gamma = \oint_{\mathcal{C}} A \cdot dq, \tag{1}$$

where A is the Berry connection of the vacuum bundle.
Invariant mass is not fundamental but emergent.

2 Vacuum Curvature Energy

The rest energy of a stable excitation is defined by

$$E_{\text{vac}} = 2\pi\hbar\,\omega\,\gamma, \tag{2}$$

where ω is the characteristic curvature frequency of the local vacuum mode.
Mass is therefore defined implicitly through

$$m := \frac{E_{\text{vac}}}{c^2} = \frac{2\pi\hbar\,\omega}{c^2}\,\gamma. \tag{3}$$

Mass becomes a derived parameter encoding geometric stiffness.

3 Ontological Statement

A particle is not an object propagating through spacetime. It is the local invariant of a non-harmonic curvature of the vacuum manifold.

The vacuum possesses stiffness κ, and γ quantifies the resistance of the vacuum to curvature smoothing.

4 Detection Principle

A detector does not measure particle impact. It measures the relaxation of vacuum holonomy.

During interaction, the residual angle γ dissipates into the thermal degrees of freedom of the detector lattice. The detection event corresponds to geometric unwinding.

5 Gravitational Consequence

Regions of enhanced residual angle γ modify the effective spacetime metric $g_{\mu\nu}$.

Gravitation is therefore an intrinsic property of persistent vacuum curvature rather than the action of matter on spacetime.

Large-scale gravitational anomalies may correspond to vacuum topological tensions without particulate constituents.

6 Conclusion

Physics is reformulated as vacuum topology. Mass is replaced by geometric holonomy. Matter is replaced by curvature invariants.