The Relativity Principle (Regime Formulation)

Invariance, Meaning, and Regime Structure

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2026

Abstract

This paper formulates the Relativity Principle as a structural constraint on meaning. The meaning of a physical quantity exists only insofar as it descends to an invariant under a theory's admissible transformations. Observational outcomes form equivalence classes—semantic regimes—under invariance relations. Only quantities constant on these classes possess observer-independent meaning.

Special Relativity appears as the exceptional case admitting a global regime. General Relativity localizes regime structure by restricting invariance to local domains.

Relativity is not a doctrine of physical relativism. It is a discipline of meaning.

1 The Relativity Principle

Definition 1.1 (Relativity Principle)**.** Let $\mathcal{O}$ be the observational space of a physical theory and let $\sim$ be the equivalence relation induced by its admissible transformations. A quantity $Q : \mathcal{O} \to S$ possesses observer-independent meaning if and only if it is constant on equivalence classes of $\sim$, i.e., if and only if it descends to a well-defined function on the quotient $\mathcal{R} = \mathcal{O}/\sim$.

Meaning is therefore equivalent to invariance.

2 Observational Space and Regimes

Let $\mathcal{O}$ denote the space of observational outcomes of a physical theory.

Admissible transformations induce an equivalence relation $\sim$ on $\mathcal{O}$.

Definition 2.1 (Semantic Regime)**.** A semantic regime is an equivalence class in the quotient

$$\mathcal{R} = \mathcal{O}/\sim .$$

Theorem 2.2 (Semantic Descent)**.** *A quantity $Q : \mathcal{O} \to S$ possesses observer-independent meaning if and only if it is constant on equivalence classes, i.e., if and only if it descends to a well-defined function on $\mathcal{R}$.*

3 Special Relativity

In Special Relativity, admissible transformations are Lorentz transformations acting globally.

Proposition 3.1. *Lorentz invariance induces a single global semantic regime.*

Corollary 3.2. *All Lorentz-invariant quantities possess global semantic meaning.*

Special Relativity removes absolute frames without destroying global invariance.

Meaning remains global because invariance remains global.

4 General Relativity

In General Relativity, admissible transformations form a local diffeomorphism groupoid.

Proposition 4.1. *Curvature restricts admissible transformations to local domains.*

Theorem 4.2. *In a generic curved spacetime (M, g), admissible transformations form only a local groupoid, and the induced equivalence relation on $\mathcal{O}$ admits no global quotient identifying all observational contexts. Consequently, semantic regimes are generically only locally defined.*

Global semantic meaning fails precisely when no global invariant section exists across local quotients.

Curvature localizes meaning before it alters geometry.

5 Observation

Observation does not generate invariance.

Let $\pi : \mathcal{O} \to \mathcal{R}$ denote the canonical quotient projection. Observation consists in representing outcomes in $\mathcal{O}$ while semantic meaning resides only in their images under π.

Observation therefore reveals invariant structure but does not create it.

6 Conclusion

Relativity reorganizes meaning through invariance. A quantity either survives transformation or it does not exist semantically.

Meaning is invariant—or it does not exist.

References

[1] A. Einstein, *On the Electrodynamics of Moving Bodies*, Annalen der Physik, 1905.

[2] A. Einstein, *The Field Equations of Gravitation*, Sitzungsberichte der Preussischen Akademie der Wissenschaften, 1915.

[3] R. M. Wald, *General Relativity*, University of Chicago Press, 1984.

[4] S. Mac Lane, *Categories for the Working Mathematician*, Springer, 1998.