Semantic Relativity

A Semantic Completion of Special Relativity

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Abstract

Special Relativity specifies how physical quantities transform between inertial frames, but it leaves the semantic status of those quantities formally underdetermined. This paper provides a semantic completion of Special Relativity by lifting its observational structure into Semantic Regime Theory and importing a non-intervening semantics of observation from Quantum Observation Theory. Relativistic observational outcomes are shown to form equivalence classes under Lorentz transformation, yielding semantic regimes as quotient objects. Only Lorentz-invariant quantities descend to well-defined regime-level structure. Familiar relativistic effects—including time dilation, length contraction, and the relativity of simultaneity—are derived as corollaries of this quotient construction rather than as physical distortions. Observation is treated as semantic projection rather than physical intervention, establishing a clean separation between ontology and epistemology. The result is a mathematically disciplined account in which Special Relativity reorganizes meaning without modifying its underlying equations.

Meaning is not absolute. It is invariant—or it does not exist.

Contents

1 Motivation and Scope

Special Relativity is traditionally presented as a theory of spacetime geometry and kinematics. Its formal structure specifies transformation laws between inertial frames and identifies invariant quantities preserved under Lorentz transformations. What remains implicit, however, is the semantic status of quantities that fail to be invariant.

This paper addresses that omission. It does not modify the equations of Special Relativity, introduce new dynamics, or reinterpret physical ontology. Instead, it makes explicit the semantic structure already enforced by relativistic invariance.

The central claim is that Special Relativity implicitly defines semantic regimes: equivalence classes of observational outcomes under admissible frame transformations. Meaning arises precisely at the level of these regimes, and only quantities that descend to regime-level invariants possess observer-independent semantic content.

This analysis places Special Relativity in the same structural family as Semantic Regime Theory (SRT) and Quantum Observation Theory (QOT). The goal is not philosophical reinterpretation but formal completion.

2 Core Definitions

This section introduces the semantic objects required to formalize Special Relativity as a regime system.

2.1 Observational Frames

Definition 2.1 (Observational Frame)**.** An observational frame is an inertial reference frame equipped with a specification of admissible observational procedures. Observational frames determine how physical quantities are reported without committing to any ontological status of those quantities outside observation.

Observational frames are idealized and non-intervening. They characterize representation, not physical evolution.

2.2 Observational Outcomes

Definition 2.2 (Observational Outcome)**.** An observational outcome is the result of applying an admissible observational procedure within a fixed observational frame. Observational outcomes consist of reported quantities such as time intervals, spatial lengths, and simultaneity relations.

Observational outcomes are semantic objects: they encode revealed information, not physical state changes.

2.3 Relativistic Semantic Regimes

Definition 2.3 (Relativistic Observational Equivalence)**.** Two observational outcomes are relativistically equivalent if they are related by a Lorentz transformation and yield identical operational predictions within their respective frames.

Definition 2.4 (Relativistic Semantic Regime)**.** A relativistic semantic regime is an equivalence class of observational outcomes under relativistic observational equivalence. Formally, if $\mathcal{O}$ denotes the set of observational outcomes, then the semantic regime space is the quotient

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

Definition 2.5 (Semantic Invariant)**.** A semantic invariant is a function $I : \mathcal{O} \to S$ such that $I(o) = I(o')$ whenever $o \sim o'$.

Lemma 2.6 (Well-Definedness of Semantic Regimes)**.** *The quotient $\mathcal{R} = \mathcal{O}/\sim$ is well-defined, and semantic invariants descend uniquely to functions on $\mathcal{R}$.*

Proof. Lorentz transformations form a group, and relativistic observational equivalence is induced by group action preserving operational predictions. Semantic invariants are constant on equivalence classes and therefore factor through the quotient. □

3 Special Relativity as a Regime System

Let $\mathcal{F}$ denote the set of inertial frames, and let $\mathcal{O}_F$ denote the observational outcomes obtainable within frame F.

Definition 3.1 (Relativistic Observational Space)**.** The relativistic observational space is the disjoint union

$$\mathcal{O} = \bigsqcup_{F \in \mathcal{F}} \mathcal{O}_F.$$

Lorentz transformations act naturally on $\mathcal{O}$.

Definition 3.2 (Lorentz Action on Observations)**.** A Lorentz transformation $\Lambda : F \to F'$ induces a map $\Lambda : \mathcal{O}_F \to \mathcal{O}_{F'}$ sending observational outcomes to their transformed descriptions.

Lemma 3.3. *Relativistic observational equivalence is an equivalence relation on $\mathcal{O}$.*

Theorem 3.4 (Relativistic Semantic Invariants)**.** *All Lorentz-invariant quantities descend to well-defined functions on the regime space $\mathcal{R}$.*

Proof. Lorentz invariance implies constancy across equivalence classes, which is precisely the descent condition. □

Remark 3.5. Special Relativity enforces semantic regimes implicitly. The quotient structure is not imposed; it is unavoidable.

4 Lifting Special Relativity into Semantic Regime Theory

Definition 4.1 (Category of Special Relativity)**.** Let **SR** denote the category whose objects are inertial frames and whose morphisms are Lorentz transformations.

Definition 4.2 (Category of Semantic Regimes)**.** Let **SRT** denote the category whose objects are semantic regimes and whose morphisms preserve semantic invariants.

Theorem 4.3 (Relativistic Semantic Lift)**.** *There exists a functor*

$$\mathcal{F}_{\mathrm{SR}\to\mathrm{SRT}} : \mathbf{SR} \to \mathbf{SRT}$$

mapping inertial frames to relativistic semantic regimes and Lorentz transformations to regime-preserving morphisms.

Remark 4.4. The lift preserves invariance and discards frame-dependent metric structure.

5 Observation Without Intervention

Definition 5.1 (Observation as Semantic Projection)**.** Observation is a projection $\pi : \mathcal{O} \to \mathcal{R}$ that preserves semantic invariants while discarding representational detail.

Theorem 5.2 (Non-Intervention of Observation)**.** *Observation does not alter physical state; it alters only semantic representation.*

Corollary 5.3. *Relativistic measurement does not physically modify clocks or rods.*

Remark 5.4. No clock changes. The regime changes.

6 Semantic Interpretation of Relativistic Effects

Corollary 6.1. *Time dilation, length contraction, and relativity of simultaneity arise from failure of metric quantities to descend to semantic invariants.*

Remark 6.2. Relativistic "effects" are semantic projections, not physical distortions.

7 Epistemic Scope and Non-Goals

This paper does not modify relativistic dynamics, propose new ontology, or introduce interpretive metaphysics. Its scope is structural and semantic.

8 Conclusion

Special Relativity reorganizes meaning without altering physics. Semantic regimes are forced by invariance, not chosen by interpretation. Observation reveals only what invariance permits to remain.

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

A Appendix E: References

References

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

[2] A. Einstein, *Relativity: The Special and the General Theory*, Henry Holt, 1916.

[3] H. Minkowski, *Space and Time*, 1908.

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

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

[6] A. Diamond, *Semantic Regime Theory*, 2026.

[7] A. Diamond, *Quantum Observation Theory*, 2026.