

# The Relativity Principle (Regime Formulation)

A Unifying Principle for Meaning and Observation in Physical Theories

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## Abstract

This paper introduces the Semantic Relativity Principle, which states that the meaning of a physical quantity is relative to the semantic and epistemic regimes permitted by a theory’s invariance structure and observational constraints. Meaning is shown to arise only through descent under admissible transformations, while knowledge is limited by access prior to interpretation. Semantic and epistemic regimes are formalized and shown to mediate all observer-independent content. Special Relativity is analyzed as a theory admitting a single global semantic regime, whereas General Relativity localizes meaning by replacing global symmetry with local invariance under diffeomorphisms. Observation is treated as a non-intervening projection that reveals only what invariance allows to survive. Many apparent paradoxes in relativistic physics are traced to demands for meaning or knowledge that exceed regime structure rather than to physical inconsistency.

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

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# 1 The Semantic Relativity Principle

In this section, we state the Semantic Relativity Principle precisely, distinguish it from physical relativity, and delimit its scope. All subsequent sections elaborate consequences of this principle rather than introducing independent assumptions.

## 1.1 Statement of the Principle

[Semantic Relativity Principle] The meaning of a physical quantity is relative to the semantic and epistemic regimes permitted by a theory's invariance structure.

Equivalently, a physical quantity possesses observer-independent meaning if and only if it descends to an invariant on the appropriate regime space induced by the theory's admissible transformations and observational constraints.

This principle does not assert that physical reality is relative. It asserts that meaning is constrained by invariance and access.

## 1.2 Semantic Relativity vs. Physical Relativity

Semantic relativity concerns the conditions under which quantities admit meaning, not the dynamical behavior of physical systems.

Physical relativity concerns how measurements transform between observers. Semantic relativity concerns which features of those measurements survive transformation and comparison.

A theory may be physically relativistic while semantically restrictive. Conversely, a theory may admit broad semantic invariance despite lacking absolute reference structures.

[Separation of Levels] Semantic relativity is logically independent of physical relativity.

Physical relativity specifies transformation laws for quantities under changes of observer or frame. Semantic relativity specifies which quantities remain invariant under those transformations and therefore admit observer-independent meaning. The former does not determine the latter.  $\square$

## 1.3 Regimes as the Carriers of Meaning

[Semantic Regime] A semantic regime is an equivalence class of observational outcomes under the invariance relations admitted by a physical theory.

Semantic regimes are determined by admissible transformations, observational constraints, and the resulting quotient structure.

[Regime-Relative Meaning] All semantic meaning in a physical theory is regime-relative.

Meaning requires invariance under the equivalence relations defining the regime. Quantities that

fail to descend under those relations do not define regime-level structure and therefore lack observer-independent meaning.  $\square$

## 1.4 Scope and Non-Claims

The Semantic Relativity Principle makes no claims about the ontology of physical systems, the truth or falsity of specific dynamical laws, or the completeness of any particular physical theory.

It does not deny realism, objectivity, or physical determinacy.

The principle constrains what can be meant, not what exists. It is a structural principle governing interpretation, not a metaphysical doctrine.

## 1.5 Structural Consequences

From the Semantic Relativity Principle, the following consequences follow immediately:

1. Meaning is inseparable from invariance.
2. Loss of invariance entails loss of global meaning.
3. Regime fragmentation precedes interpretive ambiguity.
4. Observation constrains meaning by constraining access.

These consequences will be instantiated in later sections for Special Relativity, General Relativity, and observation-based theories.

*There is no absolute meaning. Meaning exists only where invariance permits it.*

# 2 Semantic and Epistemic Regimes

This section formalizes semantic and epistemic regimes and clarifies their logical relationship. These regimes are the carriers of meaning and knowledge, respectively, under the Semantic Relativity Principle.

## 2.1 Semantic Regimes (Ontology)

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

[Semantic Equivalence] Two observational outcomes  $o, o' \in \mathcal{O}$  are semantically equivalent if they are related by an admissible transformation of the theory that preserves operational predictions.

[Semantic Regime] A semantic regime is an equivalence class of observational outcomes under semantic equivalence.

Define the semantic regime space as the quotient

$$\mathcal{R} = \mathcal{O} / \sim_{\text{sem}} .$$

Elements of  $\mathcal{R}$  represent observer-independent semantic structure.

[Semantic Descent] A quantity possesses semantic meaning if and only if it descends to a well-defined function on  $\mathcal{R}$ .

## 2.2 Epistemic Regimes (Knowledge)

Semantic regimes classify meaning; epistemic regimes classify access.

[Epistemic State] An epistemic state is a subset

$$E \subseteq \mathcal{O}$$

consisting of all observational outcomes accessible to an observer within a fixed observational context.

[Epistemic Equivalence] Two epistemic states  $E$  and  $E'$  are epistemically equivalent if there exists a bijection between their accessible outcomes preserving operational distinguishability.

[Epistemic Regime] An epistemic regime is an equivalence class of epistemic states under epistemic equivalence.

Define the epistemic regime space as

$$\mathcal{E} = \{E \subseteq \mathcal{O}\} / \sim_{\text{epi}} .$$

Elements of  $\mathcal{E}$  represent observer-independent knowledge structure.

## 2.3 Precedence and Dependence

[Epistemic Precedence] Epistemic regimes are logically prior to semantic regimes.

Semantic identification presupposes access to observational outcomes. Epistemic regimes classify access itself, while semantic regimes classify meaning across outcomes. Therefore epistemic regimes must be defined before semantic regimes can be formed.  $\square$

[Constraint on Meaning] No semantic invariant can exceed the scope permitted by epistemic regimes.

Semantic invariants require comparison across observational outcomes. Such comparison is limited by epistemic access. Hence semantic meaning is constrained by epistemic regimes.  $\square$

[Regimes as Carriers of Relativity] Under the Semantic Relativity Principle, all observer-independent meaning and knowledge are mediated by semantic and epistemic regimes determined by a theory's invariance and access structure.

Semantic regimes determine what can be meant. Epistemic regimes determine what can be known. Physical theories differ not only in what they posit to exist, but in the regimes their structure permits.

*Knowledge has boundaries. Meaning has stricter ones. Regimes decide both.*

### 3 Invariance as the Source of Meaning

In this section, we show that invariance is not merely a structural feature of physical theories but the necessary condition for semantic meaning. The Semantic Relativity Principle follows directly from the fact that only invariant structure survives comparison across regimes.

#### 3.1 Symmetry and Equivalence

Every physical theory admits a class of admissible transformations under which operational predictions are preserved.

[Admissible Transformations] An admissible transformation is a transformation of observational contexts that preserves operational outcomes and observational distinguishability.

Examples include Lorentz transformations in Special Relativity and diffeomorphisms in General Relativity.

[Equivalence from Invariance] Admissible transformations induce equivalence relations on observational outcomes.

If two outcomes are related by an admissible transformation preserving operational predictions, they are indistinguishable within the theory. Such indistinguishability defines an equivalence relation.  $\square$

#### 3.2 Quotient Structure and Semantic Descent

[Semantic Quotient] Let  $\sim$  be the equivalence relation induced by admissible transformations. The semantic quotient is the regime space

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

[Semantic Descent Theorem] A quantity possesses observer-independent semantic meaning if and

only if it descends to a well-defined function on the semantic quotient  $\mathcal{R}$ .

A function descends to the quotient precisely when it is constant on equivalence classes. Constancy under admissible transformations is therefore necessary and sufficient for regime-level meaning.  $\square$

### 3.3 Universal Property of Meaning

[Universal Property of Semantic Meaning] The semantic regime space  $\mathcal{R}$  is terminal among all factorizations of the observational outcome space through invariant maps.

That is, for any set  $X$  and any function

$$f : \mathcal{O} \rightarrow X$$

that is invariant under all admissible transformations, there exists a unique map

$$\tilde{f} : \mathcal{R} \rightarrow X$$

such that  $f = \tilde{f} \circ \pi$ , where  $\pi : \mathcal{O} \rightarrow \mathcal{R}$  is the quotient projection.

Invariance of  $f$  implies constancy on equivalence classes. By the universal property of quotients, such a function factors uniquely through the quotient map.  $\square$

This theorem formalizes the claim that semantic meaning is not chosen or imposed but forced by invariance.

### 3.4 What It Means for Meaning to Exist

[Meaning Requires Invariance] Any quantity that varies under admissible transformations lacks observer-independent semantic meaning.

Variation under admissible transformations implies failure of constancy on equivalence classes. By semantic descent, such quantities do not define functions on  $\mathcal{R}$ .  $\square$

[Semantic Extinction] Loss of invariance entails loss of semantic meaning, independent of physical existence.

Meaning is not intrinsic to quantities. It is a relational property conferred only by invariance under admissible transformations.

*Meaning is not measured. Meaning survives transformation—or it does not exist.*

## 4 Special Relativity as a Semantic Case

In this section, we show that Special Relativity instantiates the Semantic Relativity Principle in its most permissive form. The global symmetry structure of flat spacetime permits a single semantic regime and therefore admits global semantic meaning.

### 4.1 Lorentz Invariance and Global Regimes

[Global Admissible Transformations] Lorentz transformations act globally on observational contexts in Special Relativity and preserve operational predictions.

Lorentz transformations preserve the spacetime interval and causal structure of Minkowski spacetime. All inertial frames are related by such transformations, which preserve physical laws.  $\square$

[Existence of a Global Semantic Regime] Special Relativity admits a single global semantic regime.

All admissible transformations act globally and relate all observational contexts. The induced equivalence relation therefore yields a single equivalence class.  $\square$

### 4.2 Global Semantic Descent

[Global Semantic Descent in Special Relativity] In Special Relativity, every Lorentz-invariant quantity descends to a global semantic invariant.

Lorentz-invariant quantities are constant on equivalence classes induced by global admissible transformations. Since these classes extend across all contexts, descent is global.  $\square$

### 4.3 Semantic Relativity Without Absolutes

[Absence of Absolutes Without Semantic Loss] The absence of absolute frames in Special Relativity does not entail loss of global semantic meaning.

Semantic meaning depends on invariance, not on the existence of privileged descriptions. Lorentz invariance suffices to sustain a global regime.  $\square$

Special Relativity removes privileged descriptions while preserving invariant meaning. It is not a theory of semantic relativism but of semantic discipline.

*Meaning remains global because invariance remains global.*

## 5 General Relativity as a Semantic Case

In this section, we show that General Relativity enforces the Semantic Relativity Principle in a fundamentally stricter form. Local invariance replaces global symmetry, fragmenting semantic

regimes and eliminating global meaning.

## 5.1 Diffeomorphism Invariance and Locality

[Admissible Transformation Groupoid] The admissible transformations of a physical theory form a groupoid  $\mathcal{G}$  acting on the observational outcome space  $\mathcal{O}$ .

Objects of  $\mathcal{G}$  are observational contexts; morphisms are admissible transformations preserving operational predictions.

[Local Admissible Transformations] In General Relativity, admissible transformations act locally and do not extend globally in generic curved spacetimes.

Diffeomorphisms preserve operational predictions only within domains where they are well-defined. Curvature obstructs their global extension.  $\square$

## 5.2 Semantic Regimes as Orbits

[Semantic Regimes as Groupoid Orbits] Semantic regimes are precisely the orbits of the groupoid action of  $\mathcal{G}$  on  $\mathcal{O}$ .

Two outcomes lie in the same orbit if and only if they are related by a sequence of admissible transformations. This is exactly semantic equivalence.  $\square$

## 5.3 Global vs. Local Quotient Structure

[Global vs. Local Semantic Quotients] Special Relativity admits a global semantic quotient

$$\mathcal{R} = \mathcal{O}/\mathcal{G},$$

whereas General Relativity admits only a local quotient structure given by a sheaf of semantic regimes

$$\{\mathcal{O}_U/\mathcal{G}_U\}_{U \subset M},$$

where  $U$  ranges over local spacetime regions.

## 5.4 Semantic Localization

[Semantic Localization] In General Relativity, global semantic meaning fails precisely when the local semantic quotient sheaf admits no global sections.

Global semantic meaning would require a global section selecting compatible representatives across all local quotients. Curvature generically obstructs such compatibility.  $\square$

General Relativity does not destroy meaning by altering geometry. It destroys global meaning by eliminating the invariance required to sustain it.

*Curvature localizes meaning before it alters geometry.*

## 6 Observation and the Semantic Relativity Principle

In this section, we show how observation operates under the Semantic Relativity Principle. Observation does not generate meaning, select invariants, or override regime structure. It projects accessible outcomes into semantic and epistemic regimes already permitted by a theory’s invariance and access constraints.

### 6.1 Observation Without Intervention

[Observational Projection] An observation is a projection

$$\pi : \mathcal{O}_E \longrightarrow \mathcal{R}$$

from observational outcomes accessible within an epistemic state  $E \subseteq \mathcal{O}$  to the corresponding semantic regime  $\mathcal{R}$ .

Observation alters representation, not physical state.

[Non-Intervention of Observation] Observation does not modify the ontology of a physical system.

Observational projection maps outcomes to regime-level structure without executing, evolving, or intervening in physical dynamics. Since it commutes with all admissible transformations, it does not alter ontological state.  $\square$

### 6.2 Regime-Bounded Observation

[Regime-Bounded Observation] Observation cannot extend semantic or epistemic regimes beyond those permitted by a theory’s invariance and access structure.

Observation is defined only on accessible outcomes within an epistemic regime. Semantic regimes are fixed by admissible transformations. Since observation creates neither access nor invariance, it cannot enlarge regime structure.  $\square$

### 6.3 Invariance Precedes Observation

[Priority of Invariance] Invariance determines what observation can reveal.

Only quantities invariant under admissible transformations descend to semantic regimes. Observation projects outcomes into these regimes but cannot promote non-invariant quantities to invariant

status.  $\square$

Observation does not ground meaning. Meaning grounds observation.

*Observation witnesses invariance. It does not create it.*

## 7 The Semantic Relativity Principle Across Physical Theories

In this section, we show that the Semantic Relativity Principle is theory-agnostic. Differences between physical theories arise from the regimes they permit, not from changes to the principle itself.

### 7.1 Theory Independence

[Theory Independence of the Principle] The Semantic Relativity Principle applies to any physical theory admitting:

1. a space of observational outcomes,
2. admissible transformations preserving operational predictions,
3. constraints on observational access.

These elements induce equivalence relations on outcomes, yielding semantic and epistemic regimes. Meaning arises through descent to the corresponding quotient structure, independently of the theory's ontology or dynamics.  $\square$

### 7.2 Regimes as a Unifying Structure

[Universality of Regime Structure] Semantic and epistemic regimes provide a unifying structural description across disparate physical theories.

While admissible transformations and access constraints differ between theories, the induced regime construction is uniform. Regimes therefore form a shared semantic substrate.  $\square$

### 7.3 Beyond Relativity

The Semantic Relativity Principle anticipates application to:

- gauge theories, where redundancy defines semantic quotients,
- quantum theory, where superposition and measurement constrain access,
- quantum field theory, where locality and renormalization restrict semantic comparability.

In each case, meaning is determined by invariance and bounded by access.

The principle unifies theories by constraining interpretation, not by reducing ontology.

*Theories differ in what they describe. They differ more sharply in what they allow to mean.*

## 8 Consequences of the Semantic Relativity Principle

In this section, we derive general consequences of the Semantic Relativity Principle for interpretation, paradox resolution, and theory development.

### 8.1 Limits on Meaningful Questions

[Regime-Bounded Meaningfulness] A question is meaningful only if it refers to quantities that descend to invariants within a shared semantic or epistemic regime.

Meaning requires invariance and access. Questions presupposing quantities beyond regime structure fail to satisfy these conditions and are ill-posed.  $\square$

### 8.2 Structural Resolution of Paradoxes

[Paradoxes as Regime Violations] Many apparent paradoxes arise from violations of regime structure rather than from physical inconsistency.

Paradoxes emerge when quantities are compared across contexts lacking shared invariance or access. Respecting regime boundaries dissolves the contradiction.  $\square$

### 8.3 Semantic vs. Physical Disagreement

[Disentangling Disagreement] Disagreements may be semantic rather than physical.

If competing descriptions differ only in non-descending quantities, no semantic disagreement exists. Genuine physical disagreement requires divergence at the regime-invariant level.  $\square$

Not every unresolved question is unanswered. Some questions are unformulable.

## 9 Conclusion

We have formulated the Semantic Relativity Principle as a unifying constraint on meaning and observation in physical theories. Meaning arises only through invariance, while knowledge is bounded by epistemic access. Semantic and epistemic regimes mediate all observer-independent content.

Special Relativity appears as the exceptional case in which global semantic regimes persist. General Relativity demonstrates how curvature localizes meaning by eliminating global invariance. Observation was shown to project accessible outcomes without generating meaning or overriding regime structure.

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

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