Semantic Relativity

A Completion of Special Relativity

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Abstract

Special Relativity specifies how measurements transform between inertial frames but leaves implicit the semantic structure of those measurements. This paper formalizes Special Relativity as a regime system: observational outcomes form equivalence classes under Lorentz transformations, and only Lorentz-invariant quantities descend to regime-level meaning.

Time dilation, length contraction, and relativity of simultaneity are shown to arise from representational change rather than physical distortion.

1 Observational Space

Let $\mathcal{F}$ denote inertial frames and let $\mathcal{O}_F$ denote observational outcomes in frame F.

Define the total observational space

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

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

2 Relativistic Semantic Regimes

Definition 2.1. Two outcomes are equivalent if they are related by a Lorentz transformation preserving operational predictions.

Definition 2.2. The semantic regime space is the quotient

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

Theorem 2.3 (Descent Criterion)**.** *A function $q : \mathcal{O} \to S$ descends to a unique function $\tilde{q} : \mathcal{R} \to S$ if and only if $q(o) = q(o')$ whenever $o \sim o'$.*

3 Interpretation of Relativistic Effects

Let $q : \mathcal{O} \to S$ be a quantity defined on observational outcomes.

By the descent theorem above, q possesses regime-level meaning if and only if it is constant on equivalence classes induced by Lorentz transformations. Equivalently, q must factor through the quotient projection

$$\pi : \mathcal{O} \to \mathcal{R}.$$

If q varies across Lorentz-related outcomes, then q does not descend to a well-defined function on $\mathcal{R}$ and therefore does not define observer-independent semantic structure.

Time dilation, length contraction, and relativity of simultaneity are precisely quantities of this type: they vary under Lorentz transformation and therefore fail to define functions on the Lorentz quotient $\mathcal{R}$.

They are not distortions of physical objects. They are artifacts of comparing representations prior to descent.

No clock changes. The regime changes.

4 Conclusion

Special Relativity reorganizes meaning without altering physics. It is a theory of invariant structure, not distorted objects.

References

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

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