Curved Propagation vs. Curved Space

Maxwell and Einstein — Interpretation vs. Mathematics

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One-Sentence Summary. Apparent relativistic effects arise from the dynamics of electromagnetic energy transport, not from curvature or deformation of space itself.

Abstract. We examine the origin of relativistic kinematics by separating physical propagation from geometric interpretation. We show that Maxwell's equations, forced by continuity and divergence-free energy transport, already imply hyperbolic kinematics and Lorentz-type transformations. No curvature of space or fusion of space and time is required. Einstein's geometric interpretation reproduces the mathematics but misidentifies its cause. The observed phenomena are consequences of curved propagation paths and finite transport rates of electromagnetic energy, not properties of space itself.

Keywords. Maxwell theory, energy transport, continuity equation, divergence-free flow, Lorentz transformations, curved propagation, foundations of relativity

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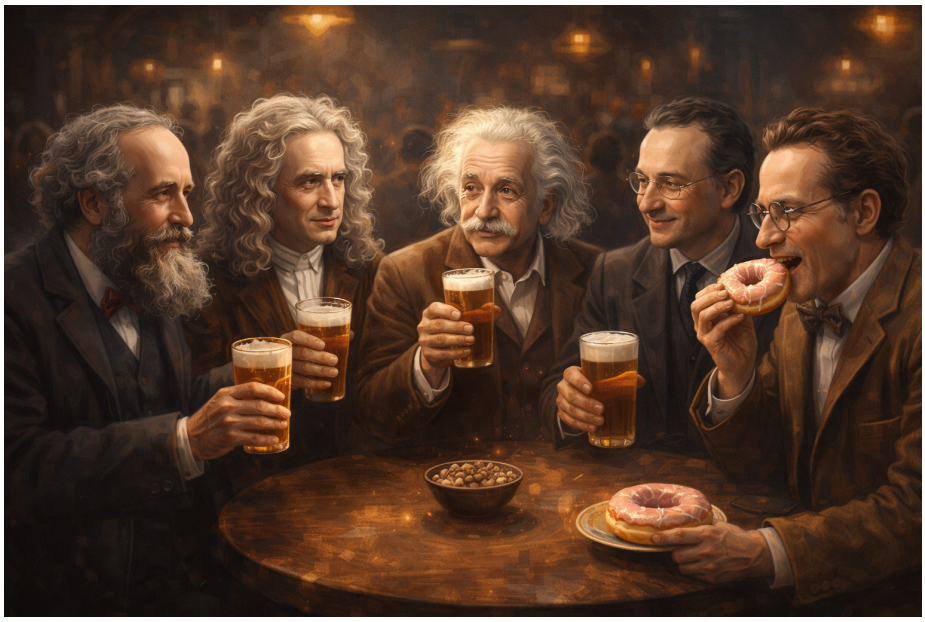

Figure 1: The big ones sharing a good one.

1. Motivation

Relativistic phenomena are often presented as evidence that *space itself* is non-Euclidean or that space and time form a single geometric object.

This document argues the opposite.

The observed effects traditionally attributed to geometric deformation arise instead from the **dynamics of electromagnetic energy transport**. The mathematics used in relativity is correct; the interpretation attached to it is not forced.

We show that:

- Maxwell electromagnetism already implies hyperbolic kinematics,
- Lorentz-type transformations follow from transport constraints,
- no curvature of space is required,
- and no fusion of space and time is necessary.

The distinction between *curved propagation* and *curved space* is central.

2. What is physically observed

Experimentally, we observe the following facts:

1. Electromagnetic energy propagates through space continuously.
2. Transport occurs at a finite, bounded rate.
3. Energy redistribution obeys continuity.
4. Energy flow is divergence-free in source-free regions.
5. Observed delays, redirections, and apparent "deflections" depend on field configuration and energy density.

None of these observations require space itself to curve, stretch, contract, or respond dynamically.

3. Maxwell theory already fixes causal structure

From source-free Maxwell theory and the continuity equation,

$$\partial_t u + \nabla \cdot \mathbf{S} = 0$$

energy transport is constrained in two essential ways:

- energy cannot appear or disappear locally,
- energy must propagate through space rather than jump.

These constraints force a **finite causal propagation rate**. This is not a postulate about coordinates or observers. It is a statement about how energy moves.

Once a finite transport rate exists, additive (Galilean) kinematics is no longer consistent. Composition of motion must respect causal ordering. Hyperbolic composition follows automatically.

4. Lorentz transformations as transport bookkeeping

Lorentz transformations are often described as transformations of "space and time."

In reality, they are **bookkeeping rules** for comparing measurements made using signals that propagate at finite speed.

They encode:

- how delays accumulate,
- how synchronization depends on propagation,
- how energy flow constrains measurement procedures.

They do **not** describe space itself changing.

The mathematics tracks propagation constraints, not geometry.

5. The Michelson–Morley misinterpretation

The Michelson–Morley experiment tested electromagnetic signal timing.

It did **not** analyze electromagnetic fields dynamically.

The null result demonstrates that Maxwell propagation enforces invariant causal structure. It does *not* demonstrate that space contracts, dilates, or reshapes itself.

Had the experiment been interpreted using full Maxwell dynamics, the conclusion would have been:

> electromagnetic energy transport already enforces the observed invariances.

Instead, geometry was invoked.

6. Lorentz and Einstein: same math, different causes

Lorentz:

- treated contraction as a dynamical response of matter to electromagnetic fields,
- remained closer to physical causation,
- but still assumed matter as primitive.

Einstein:

- removed electromagnetic dynamics from the explanation,
- reinterpreted the same mathematics as geometric structure,
- treated measurement effects as properties of space itself.

Both recover the same equations.

Only one keeps the cause.

7. Curved propagation without curved space

Electromagnetic energy does not have to move in straight lines.

Propagation can curve due to:

- superposition,
- refraction by other fields,
- self-induced delay,
- circulation and topology.

A curved path through flat space produces the same observational effects as a straight path through curved space.

Only one is required.

Nothing in Maxwell theory demands that space itself respond to energy flow.

8. Why "local flatness" is not an explanation

The notion of "local flatness" treats curvature as an approximation artifact.

But curvature and straightness are intrinsic, not local conveniences.

If Maxwell theory required curved space, local flatness would not rescue it. The fact that Maxwell transport works identically everywhere indicates that **space itself is not dynamically involved**.

Energy flow is curved. Space is not required to be.

9. The correct hierarchy

The logically forced order is:

1. Continuity of energy transport
2. Divergence-free structure
3. Curl-based electromagnetic dynamics
4. Finite propagation rate
5. Hyperbolic kinematics
6. Lorentz-type transformations
7. Geometric reinterpretation (optional)

Geometry is an interpretation layer, not a physical cause.

10. What this does and does not claim

This document claims:

- relativistic kinematics follow from Maxwell transport,

- hyperbolicity reflects causal propagation, not spatial structure,
- curved propagation suffices to explain observed effects.

It does not claim:

- that geometry is useless,
- that relativistic calculations are wrong,
- or that alternative descriptions are forbidden.

It claims only that **geometry is not required**.

11. Closing statement

Electromagnetic energy moves through space. It does so continuously, causally, and at finite rate.

From this alone follow the mathematical structures later reinterpreted as relativity.

Space does not bend to accommodate energy. Energy bends its own paths.

The mathematics survives. The interpretation changes.

Figure 2: Big ones cheering.