

Why Does a "Maximum Speed" Exist? — From Galileo's Relativity Principle Alone: There Are Only Two Relativities (Ignatowski's Theorem) — [Paper 83]

Yuuki YAMAGISHI (山岸 勇輝)
Yamagishi Complexity Torus Lab, Japan
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— *From thinking to syncing.* —

ABSTRACT

Special relativity usually begins by **postulating from on high** that "the speed of light is the same in all inertial frames." Yet in fact relativity can be derived without assuming that postulate, from far more elementary premises. This paper rereads, from the standpoint of this corpus, that old and beautiful standard result — **Ignatowski's theorem** (Ignatowski 1910–11; Frank–Rothe 1911; Lévy-Leblond 1976). The premises are only **Galileo's relativity principle + spatial homogeneity and isotropy + the group structure of the transformations (+ causality)**. From these, the coordinate transformations between inertial frames are narrowed to **exactly two families**: (1) the **Galilean transformation** (invariant speed = ∞ , absolute time), or (2) the **Lorentz transformation** (a **finite invariant speed** exists). Which branch we inhabit, and the value of the finite speed, are determined **by experiment**. We happen to live in the "finite- c branch" — that is all. **Key point (connection to the corpus)**: this reading underwrites, as a theorem, what the corpus has repeatedly stated — " **c is not a fundamental postulate or cause of the universe, but is closer to a scaffold / convention, the finite value selected at a two-way fork**" (c = velocity-space radius, Papers 60–63; local vs coordinate c as distinct roots, Paper 66; the 2019 SI redefinition making c a defined value). Moreover, the logic of "exactly two possibilities" is of the **same blood as the counting method of Paper 01 ($n = 2$ uniqueness) and Papers 64/69 (dimension census)**. **Distinct-roots discipline**: (a) the "**invariant speed**" that emerges from the group and (b) the "**speed of light**" of electromagnetism are **quantities of distinct origin that merely coincide in value** (light travels at the invariant speed because the photon is massless; were the photon to have a tiny mass, light would travel slightly below the invariant speed, and the invariant speed would still exist). **Scope**: this paper neither re-derives nor replaces special relativity by a novel method (it presents a standard alternative derivation). It does **not explain why our universe is the finite branch, nor why c has the value it does (experiment decides)**. There is no new prediction; it remains a structural interpretation.

Positioning of this paper (discipline): This paper is a **structural interpretation** of established physics (the "fewer-axioms" derivation of special relativity by Ignatowski / Lévy-Leblond; Galileo's relativity principle). **It does not rewrite special relativity and claims no new derivation** — it rereads a standard alternative derivation from the corpus's "**c** = scaffold" standpoint. It contains no new physical law and no new prediction. Words such as "Universe OS" are **Layer-3 metaphors carrying the "non-science" label**, not claims of physical mechanism (quarantined in a dashed box).

1. Introduction: Relativity Without Postulating Constant Light Speed

The textbook special relativity begins from Einstein's two postulates — (i) the relativity principle, (ii) the invariance of light speed. Postulate (ii) is powerful but somehow abrupt: "why is the speed of light alone special?" The standpoint this paper presents **removes (ii) from the axioms**. All that is needed are elementary premises reaching back to Galileo.

To state the conclusion first — **pushing the relativity principle through honestly, there are exactly two ways the universe can be**: the Newton–Galileo world (no upper limit on speed, absolute time), or the Einstein–Lorentz world (a finite maximum speed exists). The constancy of light speed appears **not as a starting axiom but as a consequence of choosing the latter branch**. This is a royal-road underwriting of the intuition the corpus has long held: "**c** is not a cause but a scaffold."

2. Galileo's Relativity Principle (the Seed)

In 1632, Galileo stated the relativity principle in his "ship's cabin" thought experiment: **experiments performed inside a ship moving at constant velocity are no different from those at rest relative to the shore**. The laws of physics take the same form in all inertial frames. This is the sole physical premise of this paper, and it is Einstein's first postulate itself. The question becomes: **pushing this principle alone to its mathematical end, what coordinate transformations are permitted?**

3. Ignatowski's Theorem: There Are Exactly Two Relativities

Standard Fact (Ignatowski 1910–11 / Lévy-Leblond 1976)

Require of the coordinate transformations between inertial frames only: **(1) the relativity principle** (all inertial frames equivalent), **(2) spatial homogeneity** ($\rightarrow$ the transformation is linear), **(3) spatial isotropy**, **(4) closure as a group** (composition and inverse of permitted transformations are again permitted). Then the transformation along $\boldsymbol{x}$ is restricted to the following family, carrying a **single universal constant κ** (of dimension $[\text{speed}]^{-2}$):

$$\boldsymbol{x}' = \gamma(\boldsymbol{x} - \boldsymbol{v}t), \quad t' = \gamma(t - \kappa \boldsymbol{v} \boldsymbol{x}), \quad \gamma = \frac{1}{\sqrt{1 - \kappa v^2}}.$$

Causality (preservation of temporal order) then selects $\kappa \geq 0$. Only the value of κ remains undetermined, and **that is decided by experiment**.

The line of proof is clear. **Homogeneity** fixes the transformation to be linear; **the relativity principle + isotropy + group structure** constrain the coefficients; and at the end a single universal constant κ remains. κ is **universal** in that it takes the same value in every inertial frame, but its **magnitude is not fixed by the theory**.

4. The Two Branches: Galilean ($\kappa = 0$) and Lorentzian ($\kappa > 0$)

Branch	Universal constant	Invariant speed	Shape of the world
Galilean (Newton)	$\kappa = 0$	$c = \infty$ (no limit)	absolute time $t' = t$; velocities add without bound.
Lorentzian (Einstein)	$\kappa > 0$	$c = 1/\sqrt{\kappa}$ (finite)	spacetime unified; c the invariant maximum speed.

Observation 4.1 (Why Does a "Maximum Speed" Exist?)

"Whether a maximum speed exists" is a **two-way choice** for the universe. If $\kappa = 0$ there is no limit (Galilean); if $\kappa > 0$ there exists exactly one finite invariant speed $c = 1/\sqrt{\kappa}$ (Lorentzian). Measurement tells us our universe is the **latter** ($c \approx 3 \times 10^8$ m/s). So the **"reason a maximum speed exists" lies not in "light" but in the single fact that "our universe is on the $\kappa > 0$ branch."** The constancy of light speed is merely a consequence within this branch.

5. The Distinct-Roots Discipline: Invariant Speed and Light Speed Are Distinct Quantities That Merely Share a Value

Here the corpus's core discipline (Papers 58, 48) applies. Though often called " c = the speed of light" in one breath, there are in fact **two c 's of distinct origin**.

Face of c	Origin	Identity
invariant speed $c = 1/\sqrt{\kappa}$	relativity principle + group structure (this paper)	a structural constant of spacetime; the speed of any massless particle.
speed of light	electromagnetism (Maxwell) = the photon is massless	the instance in which light happens to travel at the invariant speed.

Observation 5.1 (Light Is Merely the "Representative" of the Invariant Speed)

Light travels at the invariant speed **because the photon is massless**, not because light defines the structure of spacetime. Were a minuscule photon mass ever found, **light would travel slightly below the invariant speed** — yet the invariant speed c would **still exist and remain invariant as the structure of spacetime**. Hence "the invariant speed" and "the speed of light" are **distinct roots that merely coincide in value**, and must not be merged. This is the distinct-root one step further upstream of Paper 66's (local c vs coordinate c).

6. Connection to the Corpus: c as Scaffold, and the Blood of "Exactly Two"

This theorem underwrites two backbones of the corpus.

- **" c is not a cause but a scaffold / convention":** c is not a first axiom of the universe but merely **one finite value** selected at a two-way fork. Its value does not follow from theory; experiment (our universe) decides it. This resonates fully with Papers 60–63 (c = velocity-space radius) and 66 (distinct roots), and with the fact that the **2019 SI redefinition made c a defined value** (from something measured to something stipulated). **But precisely:** this does not mean " c is arbitrary." **That a finite invariant speed exists is physics (structure); only "what number we call it" is the convention of units.**
- **The counting of "exactly two":** the logic that the permitted relativities are limited to two is the same method as Paper 01 (limited to $n = 2$) and Papers 64/69 (the census of special dimensions). **"Narrowing from countless possibilities to a few"** — this is a royal-road form the corpus uses repeatedly.

The Author's Vision (Layer 3, non-science label / not a mechanism, not a prediction)

In the corpus's lens (metaphor) — might the **invariant speed be the Universe OS's "maximum update rate (the upper bandwidth at which rendering propagates)"**? The Galilean branch ($\kappa = 0$) is an infinite-bandwidth OS (information arrives instantly); the Lorentzian branch ($\kappa > 0$) is a **finite-bandwidth OS** whose ceiling is c . Our universe is a "finite-bandwidth machine." — **This picture carries the non-science label.** Ignatowski's theorem needs no bandwidth and no OS; it stands on the relativity principle and group structure alone. The OS is a lens to make "why a finite speed feels natural to us" sit comfortably in the mind, not a claim of physical mechanism nor a testable proposition. Poetry as poetry, theorem as theorem — the labels kept apart.

7. Scope (What Is Shown, and What Is Not)

What is shown (descriptive):

- From the relativity principle + homogeneity/isotropy + group structure (+ causality) alone, relativity is limited to two — Galilean ($\kappa = 0$) and Lorentzian ($\kappa > 0$) (Ignatowski). Constant light speed is not an axiom but a consequence of the latter branch.
- The "invariant speed" (group/structure) and the "speed of light" (photon masslessness) are **distinct roots** that merely coincide in value (Observation 5.1).
- This reading underwrites the corpus's " c = scaffold" (60–63/66/2019 SI) and "counting to exactly two" (01/64/69).

What is not shown (restraint):

- **Special relativity is neither re-derived nor replaced.** Ignatowski / Lévy-Leblond is an established, standard alternative derivation; this paper only **presents and places** it. No new derivation, no new mathematics.
- **Why our universe is the finite branch ($\kappa > 0$) is not explained.** Which branch, and the value of c , are decided **by experiment** — not by theory. This edge is left open.
- **It does not say " c is arbitrary / variable."** That a finite invariant speed exists is physics. The convention of units (2019 SI) concerns "the name of the number," not the structure itself.
- **OS and bandwidth are Layer-3 non-science lenses.** The theorem needs none of it (§6 dashed box).
- **No new prediction is made.** It yields the same observational results as standard special relativity. Hence it remains at Layer 2 (structural interpretation).

8. Conclusion

"Why does a maximum speed exist?" — the answer is not in light. **Pushing Galileo's relativity principle to its end, the universe is narrowed to exactly two:** the Galilean branch with no limit ($\kappa = 0$), or the Lorentzian branch with a finite invariant speed ($\kappa > 0$). Measurement tells us we live in the latter. The constancy of light speed is a **consequence** of this branch, not a starting axiom. And "the invariant speed" and "the speed of light" are **distinct roots** that coincide in value only because the photon is massless.

This is a quiet, royal-road underwriting of an intuition the corpus has long held — **" c is not a building material (cause) of the universe but closer to a chosen scaffold / convention."** Yet the discipline holds: this paper does not rewrite relativity (it presents a standard alternative derivation), does not explain "why the finite branch, or why that value of c " (the province of experiment), and quarantines the "OS bandwidth" picture in a non-science Layer 3. The elementary principle Galileo saw in a ship's cabin runs in a single straight line all the way to the very skeleton of modern physics — "that a maximum speed exists." That is one page worth recording honestly.

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