

The One-Way Speed of Light Cannot Be Measured

— The Convention of Simultaneity, Its Fence, and Three Things Called a Convention — [Paper 24]

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— *From thinking to syncing.* —

ABSTRACT

Paper 95 separated convention from fact and Paper 111 wrote that light fixes only the conformal structure. **This paper treats the point where the two meet — the one-way speed of light. NO NEW PHYSICAL LAW IS CLAIMED.** First, **the round trip is c for every ϵ .** With a synchronisation parameter $\epsilon \in (0, 1)$ the one-way speeds split into $c/2\epsilon$ and $c/2(1 - \epsilon)$, yet **the round-trip time is $2L/c$ and the two-way speed is c , independently of ϵ** (computed symbolically here) (Section 2). Second, and this is the core. **Changing ϵ is nothing but a change of coordinates.** Setting $t' = t + \kappa x$ with $\kappa = (1 - 2\epsilon)/c$ makes an off-diagonal term appear in the metric, yet **solving for the null directions returns exactly the one-way speeds of Section 2** (checked at $\epsilon = 1/4, 1/2, 3/4, 9/10$). **The light cone has not moved** (Section 3). Third, **nothing observable moves.** Proper time is the length of a worldline and is untouched by a relabelling of simultaneity slices, and the Doppler ratio is built from **two events read on a single clock**, so no synchronisation enters (Section 4). Fourth, **the convention has a fence.** At $\epsilon \leq 0$ or $\epsilon \geq 1$ a one-way speed becomes negative or infinite and **the order of cause and effect breaks.** The freedom lives only inside the open interval $(0, 1)$ (Section 5). Fifth, **the brake.** Malament (1977) showed that **if simultaneity is required to be an equivalence relation definable from the causal structure and one inertial worldline alone, it is unique and equals $\epsilon = 1/2$.** Reichenbach and Malament are both right — they differ in what is allowed in a definition (Section 6). And what the corpus has called a convention falls into three depths (Section 7).

Scope of this paper: NO NEW PHYSICAL LAW IS CLAIMED. Reichenbach's ϵ , the fact that only the two-way speed is measurable, the ϵ -coordinates and Malament's theorem are **all standard.** **Nothing here contradicts relativity — the work is to draw the line between what is measured and what is stipulated.** What this paper adds is only **showing in numbers that changing ϵ does not move the light cone, writing that the fence is an open interval, separating Reichenbach from Malament by what each allows in a definition, and setting the corpus's three conventions side by side by depth.**

1. Notation and position

For two points a distance L apart, declare the arrival of the outward signal to be $t_B = t_1 + \varepsilon(t_2 - t_1)$, where t_1 is the departure and t_2 the return. The standard synchronisation is $\varepsilon = 1/2$.

Position: Paper 118 separated the logical types of dt and $d\tau$, and Paper 123 rejected the reading “the apparatus lags” in three ways. **This paper treats the question that comes before those — whether “simultaneous” at a distance is measured or decided.**

2. The round trip is c for every ε

Verification 2.1

ε	outward c_+	return c_-	two-way speed
1/4	$2c$	$2c/3$	c
1/2	c	c	c
3/4	$2c/3$	$2c$	c
9/10	$5c/9$	$5c$	c

In general the round-trip time is $L/c_+ + L/c_- = 2L/c$, in which ε cancels. (QED)

Observation 2.2

Only the round trip is measurable. To measure a single leg one must first have set two distant clocks, and the way of setting them is exactly ε . The circle cannot be escaped.

3. Changing ε is a change of coordinates

Verification 3.1: With $t' = t + \kappa x$ and $\kappa = (1 - 2\varepsilon)/c$ the interval becomes $ds^2 = -c^2 dt'^2 + 2c(1 - 2\varepsilon) dt' dx + 4\varepsilon(1 - \varepsilon) dx^2$, in which an off-diagonal term has appeared. Solving $ds^2 = 0$ for $u = dx/dt'$,

ε	the two null directions	against $c_{\pm}$ of Section 2
1/4	$-2c, 2c/3$	agree
1/2	$-c, c$	agree
3/4	$-2c/3, 2c$	agree
9/10	$-5c/9, 5c$	agree

(QED)

Observation 3.2 (this is the core)

The set of null directions is the same. What changed is only its coordinate description: ε has not moved the geometry at all.

Observation 3.3

In the language of Paper 111, ε is not even a freedom inside the conformal structure — the conformal structure itself is untouched. Where Paper 150's density was a freedom that moves the geometry, ε is a freedom that moves nothing.

4. Nothing observable moves

Verification 4.1: Along a worldline of velocity v the proper time is $T_0\sqrt{1 - v^2/c^2}$ in the standard coordinates and in the ε -coordinates alike. (QED)

Observation 4.2

Proper time is the length of a worldline (Papers 118, 121) and a relabelling of simultaneity slices cannot change it. The Doppler ratio $\sqrt{(1 - v/c)/(1 + v/c)}$ likewise reads two events on one clock, leaving no room for a synchronisation to enter.

Observation 4.3

So any experiment claiming to measure a one-way speed has assumed a synchronisation somewhere. What it measures is either the round trip, or the ϵ it assumed.

5. The fence: causality forces an open interval

Verification 5.1

ϵ	c_+	c_-	verdict
$-1/4$	$-2c$	$2c/5$	a negative speed: cause and effect swap
0	infinite	$c/2$	boundary: one leg infinitely fast
$1/2$	c	c	allowed
1	$c/2$	infinite	boundary: one leg infinitely fast
$5/4$	$2c/5$	$-2c$	a negative speed

(QED)

Observation 5.2

The convention is not “anything goes”. It is a one-parameter freedom inside the open interval $(0, 1)$, whose endpoints causality closes — an instance of Paper 95's rule that a convention is a number and not a licence.

6. The brake: Malament's theorem

Fact 6.1: Reichenbach (1928) argued that ϵ is conventional. Malament (1977) showed that **if simultaneity is required to be an equivalence relation definable from the causal structure together with a single inertial worldline, then it is unique and is the standard synchronisation, $\epsilon = 1/2$.**

Observation 6.2

Both are correct. They differ in what is allowed in a definition — Reichenbach permits any stipulation, Malament only what the causal order and one worldline can define.

Observation 6.3

So “is simultaneity conventional?” has no answer until one says which definitions count. One word, two roots (Paper 17). In the corpus's idiom, writing the address here means writing which frame of definitions one is standing in.

7. A census: three things called a convention

Observation 7.1

what is free	type	what moves when it is changed	address
the ε of simultaneity	a choice of coordinates	nothing (not even the cone)	here
the density in a conformal class	a geometric freedom	the metric (volumes, distances)	Paper 150
the choice of units	an assignment of numbers	the numbers (invariants do not)	Papers 95, 35

Observation 7.2

All three have been called conventions, and they sit at different depths. The separator is what moves when the choice is remade — nothing, the geometry, or the numbers.

8. Conclusion

1. The round trip is c for every ε (Ver. 2.1). Only the round trip is measurable.
2. Changing ε is a change of coordinates (Ver. 3.1). The null directions do not move.

3. **Nothing observable moves (Ver. 4.1): neither proper time nor the Doppler ratio contains a synchronisation.**
4. **The fence is the open interval $(0, 1)$ (Ver. 5.1), closed at the ends by causality.**
5. **Malament's theorem forces $\epsilon = 1/2$ (Fact 6.1) — once what counts as a definition is narrowed.**
6. **“Convention” falls into three depths (Obs. 7.1).**

Closing: The one-way speed of light cannot be measured, and not for want of apparatus. What would have to be settled first, in order to measure it, is that very number. And changing the settlement did not move the light cone by a hair — what moved were the markings on the paper.

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