Why Should Causality Be Physical While Simultaneity Is Merely Descriptive?

One of the difficulties encountered in debates concerning special relativity relates to the exact physical status attributed to the structure of space-time.

When relativity is presented, it is generally stated that reference frames are merely tools of description. Two observers in relative motion may assign different coordinates to the same event without this implying any physical contradiction. From this perspective, planes of simultaneity appear as constructions that depend on the chosen reference frame.

However, when the discussion turns to causality, the nature of the discourse often changes.

Indeed, relativity asserts that there is a fundamental physical distinction between three types of intervals:

- timelike intervals;
- lightlike intervals;
- spacelike intervals.

This distinction makes it possible, in particular, to determine which events can be causally connected and which cannot. Light cones are then no longer presented as mere descriptive tools, but as the expression of a real physical structure of the world.

A question therefore arises.

Why should the same geometrical structure receive two different statuses depending on the aspect being considered?

When it comes to causal relations, the geometry of space-time appears to possess a strong physical significance. It determines what can influence what, what can be a cause or an effect, and what belongs to the causal past or causal future of an event.

By contrast, when a difficulty arises concerning planes of simultaneity or the physical states attributed to distant objects, it is often argued that these planes are merely descriptive tools that depend on the chosen reference frame.

This difference in treatment deserves examination.

Timelike, lightlike, and spacelike intervals all belong to one and the same geometrical structure. They are not three independent constructions, but three aspects of a single formalism.

On what basis, then, should one part of this structure be granted genuine physical significance while another part is reduced to a mere descriptive convention?

The question becomes particularly important when certain interpretations of relativity invoke this very same structure in support of strong ontological claims such as:

- the absence of a universal present;
- the block universe;
- eternalism;
- the idea that past, present, and future coexist in some manner.

Such conclusions go far beyond the purely descriptive domain. They concern the very nature of reality.

If planes of simultaneity possess no physical significance and constitute nothing more than descriptive conventions, then it becomes legitimate to question the validity of the metaphysical conclusions that are sometimes derived from them.

Conversely, if planes of simultaneity themselves possess genuine physical significance, then the consequences of the relativity of simultaneity must be examined all the way through, including when they concern the physical existence of bodies and their respective states.

The fundamental question may therefore not be simultaneity alone.

More broadly, it concerns the physical status of the structure of space-time itself.

Is it merely a descriptive tool that helps organize our observations?

Or does it directly describe the real structure of the world?

As long as this question remains ambiguous, a tension persists between the descriptive interpretation of relativity and the ontological conclusions that are sometimes drawn from it.