THE BLOCK UNIVERSE

Origins, Debates, and Refutation by Reductio ad Absurdum

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Date: 7 November 2026

The concept of the block universe lies at one of the most important crossroads between theoretical physics and metaphysics. While scientific tradition regards it as a direct consequence of the geometrization of time, a rigorous logical and ontological analysis reveals that this model rests on specific local physical assumptions, whose detailed examination calls its very validity into question.

I. The Origins of the Block-Universe Concept

The block universe (or eternalism) is the view that space and time form a fixed four-dimensional continuum. In this model, past, present, and future have the same existential status: future events already exist at their spacetime coordinates, just as past events have not disappeared.

Historically, this concept developed in two major stages:

1. Einstein's Special Relativity (1905): By formulating his second postulate—the invariance of the speed of light—Albert Einstein demonstrates that two observers in relative motion do not agree on the simultaneity of distant events. The “universal present” of Newtonian physics is abolished: each reference frame has its own temporal rate.

2. Minkowski's Spatialization (1908): The mathematician Hermann Minkowski unifies space and time into a rigid four-dimensional geometric entity: spacetime. The trajectories of objects become static “worldlines.” Albert Einstein fully embraces this vision, describing the flow of time and the present instant as illusions, and objective reality as a frozen physical world.

II. Traditional Debates in the Philosophy of Science

Faced with this vision of a petrified world, philosophy of science has historically divided into several camps:

Classical Eternalism (Rietdijk, 1966; Putnam, 1967): These authors develop arguments based on the relativity of simultaneity to support the reality of future events. The “Andromeda paradox,” later presented by Roger Penrose, illustrates a related line of reasoning.

Presentism and the Growing Block: Conversely, proponents of becoming maintain either that only the present exists (presentism), or that the past and present form a

solid block to which the future is progressively added (the growing block), thus seeking to preserve the idea of an open and undetermined future.

The Informational or Instrumentalist Approach: Some physicists seek to sidestep the problem by asserting that simultaneity planes are merely “mathematical conventions” or abstract coordinate tools (like contour lines on a map), with no bearing on the intrinsic reality of things.

III. The Classical Logical Sequence: From Light to the Block Universe

To understand the significance of this critique, it is essential to reconstruct the sequence leading from the invariance of the speed of light to the block-universe interpretation. This sequence involves three stages, the last of which introduces ontological premises:

Invariance of the one-way speed of light, c

↓ With the other relativistic postulates and Einstein synchronization

Relativity of simultaneity

↓ With the ontological premises of the Rietdijk–Putnam argument

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1. The Postulate of One-Way Invariance (P)

The second postulate of special relativity states that the speed of light in a vacuum has the same value, denoted c, in all inertial reference frames, independently of the motion of the source.

The epistemological problem of measurement: To measure speed along an open, one-way path from point A to point B, the departure time at A must be compared with the arrival time at B. This requires a procedure for synchronizing the two distant clocks.

Einstein's convention: To synchronize these clocks, Einstein uses a light signal and assumes that the outward and return journeys take equal times. This procedure assigns the same speed of light in both directions. It is therefore important to distinguish what belongs to the choice of synchronization from the physical significance attributed to one-way invariance.

2. Relativity of Simultaneity and Its Physical Significance (P → S)

Within the framework of the relativistic postulates and this synchronization, simultaneity becomes relative to motion. Two inertial observers in relative motion generally do not assign simultaneity to the same distant events. Their simultaneity hyperplanes have different orientations in a common spacetime representation.

The decisive question concerns the significance of this difference: does it describe only an assignment of temporal coordinates, or does it involve real physical states of

distant bodies? The analysis seeks to show that the invariance of the one-way speed of light, when asserted as a universal physical property, entails the claim that simultaneity planes correspond to real physical states of distant bodies.

3. Putnam's Ontological Realism: Eternalism

In his 1967 article, Time and Physical Geometry, Hilary Putnam develops an argument for the reality of future events, related to the argument advanced by Wim Rietdijk in 1966.

The central idea is that events simultaneous with an observer must be regarded as real, without granting ontological privilege to any particular reference frame.

A distant event may be simultaneous with the local event “here and now” in observer B's reference frame, while being future relative to that same local event in observer A's reference frame.

If the events connected in this way are granted the same reality, and this attribution of reality extends from one observer to another, certain events that are future for A must also be regarded as real.

The eternalist conclusion: Future events are not excluded from reality merely because they are future for an observer. Past, present, and future belong to one and the same four-dimensional reality, without a universal present delimiting what exists.

It is this sequence, and especially the transition from simultaneity to physical existence, that the present analysis seeks to subject to an internal critique through the shuttle-and-missile objection.

IV. Clarifications and Logical Demonstration of the Shuttle-and-Missile Objection

This analysis reframes the debate by starting not from an a priori philosophical preference (such as presentism), but from a logical analysis internal to the postulates of Einsteinian physics.

1. The Necessary Physical Reality of Relative Simultaneity

Contrary to claims that reduce simultaneity to a mere abstract geometric convention, the invariance of the speed of light on a one-way journey (rather than a metrological round trip) necessarily requires lines of simultaneity to correspond to real physical states of matter.

In Einstein's train thought experiment, at the precise moment when the stationmaster and the passenger pass each other at the same spatial position, the one-way postulate imposes a distortion of existence:

For the stationmaster, the light ray (or flash) at the rear of the train has been emitted: it physically exists.

For the passenger on the train, that same ray has not yet been emitted: it does not yet exist at its point of origin.

2. The Ontological Foundation of the Block Universe: “Existing Relative to”

This rupture introduces the concept of “existing relative to.” One and the same distant physical body has a dual existential status, relative to the motion of the local observer: it exists for one observer but not for the other.

The block universe is therefore not merely an aesthetic or mathematical option: it becomes the indispensable metaphysical framework for giving coherence to this notion of “existing relative to.” To prevent reality from dissolving into a relativism in which objects appear and disappear according to each observer's speed, eternalism is compelled to spatialize time and to assert the static coexistence of all instants.

3. Proof by Contradiction and the Law of Excluded Middle

The Decisive Step: The Shuttle-and-Missile Objection as an Extension of the Train Thought Experiment

Consider a shuttle and a distant base located behind it. The shuttle accelerates away from this base, from which a missile is launched.

In a construction using inertial reference frames instantaneously comoving with the shuttle, the orientation of the simultaneity planes changes with its velocity. The configuration examined here is chosen so that a launch initially classified as already having occurred relative to the shuttle is subsequently classified as not yet having occurred during its acceleration.

To make the question concern the existence of the missile itself, one may specify that its assembly is completed at the moment of launch. Before then, its components exist, but the missile does not yet exist as an assembled object.

Under the assumption that simultaneity planes have ontological significance, the succession of states attributed relative to the shuttle then becomes:

The missile already exists as an assembled and launched object;

then the missile does not yet exist as such.

This change results from the shuttle's motion and the alteration of its associated planes, without any local action by the shuttle being exerted on the missile.

The Physical Difficulty Raised

The objection concerns whether this succession can be given physical meaning. How can the missile's local history be reconciled with the states of existence attributed to it relative to the shuttle during the latter's acceleration?

The analysis maintains that examining the missile in this framework reveals an incompatibility that cannot be resolved merely by asserting that all events exist in the

block universe. It is at this level that the internal critique is situated: in certain configurations, the block-universe conception is incompatible with a physically coherent description of the missile's trajectory relative to the shuttle.

The Role of the Excluded Middle

Once the physical meaning of “existing relative to” has been clarified, the analysis poses the following alternative: if a reality exists relative to observer A,

Either it also exists relative to observer B;

Or it does not yet exist relative to B.

The law of excluded middle makes it possible to formulate this alternative; the missile objection serves to distinguish between the possibilities. The logical principle therefore does not replace the physical and ontological demonstration.

According to the conclusion defended, the inconsistency of the second possibility requires recognition of a physical existence that does not depend on the observer's motion: absolute simultaneity at the physical level, and hence a common present for the universe.

This conclusion is presented as the result of the reductio ad absurdum argument, not as its premise. Evaluating it requires referring to the detailed presentation of the objection, in which the incompatible states and the conditions under which they are incompatible must be precisely identified.

4. The Epistemological Distinction and the Two Ontological Pillars

The preceding conclusion leads to a distinction between our knowledge of simultaneity and its physical status.

At the operational and experimental level: Comparing distant events relies on signals and synchronization procedures. The assertion of a common present therefore does not, by itself, provide a method for experimentally determining which distant events belong to it.

At the physical and ontological level: This analysis nevertheless maintains that this limitation of knowledge does not rule out the existence of absolute simultaneity. The question of what exists is not the same as the question of the means available to measure it.

The approach then develops two ontological foundations.

First Pillar: The Existence of Being

Either a reality exists or it does not exist. According to this approach, physical existence cannot be fragmented into contradictory statuses depending solely on the motion of observers.

This principle expresses the ontological foundation of the position. For it to lead to the necessity of a common present, it must be articulated with the preceding critique of the physical relativity of existence; it does not replace that critique.

Second Pillar: The Relational Approach and the Present Existence of Relations

In a fully relational approach, space is not a container independent of bodies: its existence rests on the relations between them.

This approach maintains that these relations must exist presently and jointly in order to constitute space. If they ceased to exist, that which constitutes space would also cease to exist. Their propagation from one body to another therefore requires, in this conception, a shared present actuality of the realities brought into relation.

The common present thus receives a further philosophical elaboration: it is associated with the present existence of the relations constituting space.

This relational approach constitutes another stage of the argument. It must not be presented as an indispensable premise of the shuttle-and-missile objection.

Finally, a common present does not imply uniform clock rates. This approach distinguishes absolute simultaneity at the physical level from an absolute time that would flow everywhere at the same rate.

Conclusion

This objection seeks to challenge the block universe by examining the sequence linking the physical invariance of the one-way speed of light, the physical significance of relative simultaneity, and the four-dimensional coexistence of events.

The shuttle-and-missile objection is the central step in this approach. It aims to show that the existence of all events in a block is not sufficient to resolve the difficulty raised by the physical states attributed to the missile relative to an accelerating shuttle.

The conclusion defended is that of absolute simultaneity at the physical level, independent of the motion of observers. It is then developed further through reflection on the existence of being and the joint present actuality of the relations constituting space.

Understood in this way, the approach does not simply oppose presentism to eternalism: it seeks to make the common present the conclusion of an internal examination of physical hypotheses, and then the starting point for a philosophical reconstruction.