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# Examining the Einstein-Bergson Controversy about Time Considering the Time-Energy Uncertainty Principle

**Rahimeh Sufiani**✉ [1] | **Behrouz Ebrahimi**[2]

1. Corresponding Author, Associate Professor, Physics Faculty, University of Tabriz, Tabriz, Iran. Email: sofiani@tabrizu.ac.ir
2. MA Student, Tabriz Branch, Islamic Azad University, Tabriz, Iran. Email: Behruz.ebrahimi@iau.ir

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## ABSTRACT

This paper revisits the famous 1922 debate between Einstein and Bergson on the nature of time, outlining its central philosophical and scientific points of contention and re-evaluating them in light of developments in quantum physics. Einstein's conception of time is that of an objective, measurable, and relative dimension within a static four-dimensional "block universe." In contrast, Bergson conceives of time (durée) as a qualitative, continuous, and creative flow of consciousness that resists reduction to quantitative measurement. The emergence of quantum mechanics, particularly the Heisenberg time–energy uncertainty principle, introduces new complexities that challenge this dichotomy. Quantum features of time, such as intrinsic uncertainty, the indeterminacy of precise moments, and the relational role of the observer, undermine the deterministic framework of classical and relativistic physics and appear, at least superficially, to resonate with Bergson's critique of spatialized, discrete conceptions of time. However, a closer examination reveals that quantum time remains a quantitative, physical construct distinct from Bergson's qualitative durée. Drawing upon modern theories such as loop quantum gravity (as articulated by Carlo Rovelli and Lee Smolin) and the insights of contemporary philosophers, this study argues that neither a purely physical nor a purely philosophical approach can, in isolation, account for the multifaceted nature of time. Rather, a comprehensive understanding requires a synthesis of both, recognizing them as complementary perspectives on a single underlying reality.

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## Intruduction

The concept of time has long been a point of contention between philosophers and physicists. In the early twentieth century, this debate reached its peak when Albert Einstein, through his theory of relativity, proposed a conception of time that directly contradicted lived human experience and intuition. Henri Bergson, the French philosopher, challenged this physical conception by emphasizing the subjective qualities and continuous flow of time (durée = duration).

A historic and symbolic clash between two intellectual traditions took place on April 6, 1922, at the "Société française de philosophie" in Paris: the encounter between Bergson and Einstein, setting philosophy of mind and metaphysics against theoretical physics. This was not a formal debate but rather an intellectual disputation in which each articulated his position. The core of their exchange concerned the interpretation of Einstein's theory of relativity and its philosophical implications, especially regarding the nature of time. Bergson summarized his arguments by distinguishing between physical time and philosophical time (durée). He sought to demonstrate that the theory of relativity does not describe real time but only a mathematized and spatialized representation—an instrument for measurement rather than for experience. He contended that physicists had mistaken time for its spatial counterpart.

Einstein's response was unequivocal and somewhat dismissive. He reportedly stated during the meeting: "The time of the philosophers does not exist; there is only a psychological time that is distinct from physical time... The time of the philosophers is a metaphysical concept that cannot be applied in physics" [Canales 2015, 116-122]. For Einstein, physical (relativistic) time was the only real time, and our subjective sense of temporal passage was merely an epiphenomenon. From his perspective, philosophers remained captive to the illusion of a universal and absolute "now", which relativity had rendered obsolete. This rebuttal was profoundly disheartening for Bergson.

More than a century later, despite significant advances in both physics and philosophy, no definitive conclusion about the nature of time- or a consensus on the debate itself- has been reached. Divergent interpretations continue to this day.

Proponents of Einstein maintain that the subjective experience of temporal passage does not correspond to the physical reality of the universe. For instance, Julian Barbour argues that time is an illusion and that the universe consists of a set of discrete "now" configurations [Barbour 1999, 310-311]. This idea is rooted in the "block universe" interpretation of relativity, in which past, present, and future coexist simultaneously, and a universal "now" is meaningless. Similarly, analytic philosophers such as D. M. Armstrong have maintained that the sense of temporal passage is a feature of human perception rather than of reality itself. The notion of a static four-dimensional universe that we experience dynamically remains a central topic in the philosophy of time and mind [Armstrong, 1997, 284-285].

Critics of Einstein, on the other hand, argue that he overlooked the qualitative, human experience of time. Edmund Husserl emphasized "inner time-consciousness", claiming that our perception of temporal sequence- through memory, perception, and anticipation- constitutes the fundamental structure of consciousness rather than an illusion [Husserl, 1991, 79]. Martin Heidegger, in "Being and Time", defined human existence as "Being-in-the-world", inherently temporal in nature. For him, time is the horizon within which existence acquires meaning; notions such as “being-toward-death” and futural “projection” render time an existentially real phenomenon [Heidegger, 1962, 294 & 412].

Some thinkers have adopted an intermediary stance, attempting to reconcile physics and experience. Arthur Eddington introduced the concept of the arrow of time, suggesting a link between the thermodynamic arrow (the direction of increasing entropy) and the psychological arrow (the perception of temporal passage). He proposed that our subjective sense of time’s flow may ultimately be rooted in physical laws, such as the second law of thermodynamics [Eddington, 1928, chatpter 24].

Many contemporary philosophers now argue that Einstein and Bergson were addressing two distinct phenomena. For example, the philosopher of science Olyvia Goldstein notes that Einstein discussed "physical time", whereas Bergson focused on the "phenomenological experience" of time [Canales, 2015, 311-314]. These represent different descriptive layers that need not contradict each other. Initially, Einstein’s arguments appeared more persuasive due to their empirical and mathematical precision, while Bergson’s reasoning seemed subjective and speculative. Over time, however, assessments have grown more balanced. It is now often stated that Einstein was correct about "physical time"; the theory of relativity being one of the most empirically confirmed in science, while Bergson was right about "lived time".

Contemporary psychology, neuroscience, and philosophy of mind corroborate that our subjective temporal experience- shaped by emotion, memory, and expectation- differs profoundly from objective clock time. For instance, the “time dilation” we feel under stress vividly exemplifies Bergson’s notion of durée. Essentially, each was describing a different aspect of time: Einstein addressed the objective physical world, while Bergson defended the subjective dimension of human experience. Many philosophers of science now hold that these positions are not contradictory but complementary. Science studies "physical time", while philosophy and psychology explore the "phenomenology of time". Relativity explains how clocks behave under varying conditions but not why those same clocks seem to slow down unbearably when we await important news. Here, Bergson’s durée provides insight into the lived experience of time. Thus, both Einstein and Bergson were pointing to distinct yet interrelated aspects of time’s multifaceted nature. Far from contradicting one another, their perspectives together deepen our understanding of this enigmatic phenomenon.

The emergence of quantum theory has radically transformed our understanding of time, introducing entirely new properties. Can the quantum characteristics of time shed light on the tension between relativistic and phenomenological perspectives, and reveal whether a synthesis- or a separation- of physics and philosophy is possible? The aspiration to unify physical and philosophical time remains an open and profound question. This article seeks to explore that question.

## Time from Bergson's Perspective

Bergson's conception of time stands in contrast to the conventional scientific understanding. His position is defined by a key distinction between quantitative (or spatialized) time and durée (qualitative or real time) [Hyde B.V.E., 2021]. He posited that human beings apprehend time in two fundamentally different ways.

**Mathematical–Quantitative or Spatialized Time:** This is the conception of time held by science-particularly physics- and by common sense: the time of ticking clocks. It is a homogeneous quantity in which all moments are qualitatively identical, differing only in measurable quantity. It is divisible into discrete units, objective, uniform (seconds, minutes, hours), and visualizable as a straight line composed of separate points- past, present, and future- like markings on a ruler. Hence, Bergson called it "spatialized," since we grasp time through spatial metaphors. This conception of time is mechanical, predictable, and devoid of creativity. It is the notion of time with which classical science operates: time as an external parameter [Hyde B.V.E., 2021]. However, Bergson argued that this is not "real time".

## Durée (Duration) or Qualitative Time

This is the central and revolutionary concept in Bergson's philosophy. Durée is time as it is genuinely lived and experienced by consciousness. Its main characteristics are:

**Qualitative**: Each moment of time possesses a unique quality. A minute spent waiting at the dentist feels entirely different from a minute of laughter with friends, though numerically identical.

**Continuous Flow and Heterogeneous**: Real time is like a flowing river; moments are not discrete but interwoven, perpetually merging into one another. The past permeates the present and shapes the future.

**Immeasurable**: One cannot quantify the experience of love, nostalgia, or anticipation in seconds. These are irreducibly qualitative states.

**Creative**: Because the past always intertwines with the present and influences the future, the latter remains open and unpredictable. Each moment introduces novelty and creation.

**Internal and Subjective**: Durée can be apprehended only through intuition and introspection, not through rational or mathematical analysis.

Bergson's Famous Example- Sugar in Water: Bergson notes that physics can calculate the time it takes for a sugar cube to dissolve in water- say, twenty seconds. Yet this "objective time" tells us nothing about the lived experience of waiting. These twenty seconds must be lived, not merely measured; they may seem long or short, filled with impatience or anticipation. This lived duration is durée [Bergson, 2001, 100].

Bergson maintains that this qualitative time, unlike quantitative time, is "more real" because it is directly experienced in the flow of life and consciousness. For him, time possesses a creative nature: genuine evolution and innovation occur only within the framework of durée. As he famously stated, “Time is invention, or it is nothing at all” [Ansell-Pearson, 2002, 128-130].

According to Bergson, the theory of relativity describes physical time but cannot invalidate our immediate and absolute experience of the present. This lived “now” is fundamental and irreducible to physical equations. He argued that Einstein made a "philosophical mistake" by conflating real time (durée) with the measurable phenomenon studied by physics [Canales, 2015, 38-50]. Bergson did not attempt to refute Einstein’s physical theory but sought to demonstrate that it does not exhaust the truth about time- it remains silent on lived, qualitative temporality.

For Bergson, the intellect is suited to analyzing the material and static aspects of reality, whereas understanding the flow of life and consciousness requires "intuition"- an inner sympathy or direct apprehension of experience. He also believed that the past never truly vanishes but is preserved in memory, continually influencing the present.

In conclusion, Bergson viewed true time not as a mathematical line but as a qualitative, creative, and continuous flow of consciousness, directly and inwardly experienced. This perspective challenges attempts to reduce time to a mere physical quantity and underscores the inexhaustible richness and creative depth of lived human temporality.

## Time from Einstein's Perspective

Albert Einstein’s theories of special (1905) and general (1915) relativity fundamentally transformed humanity’s understanding of time. Special relativity introduces the concept of "relative time", which depends on the observer’s state of motion. This leads to several phenomena with far-reaching implications for physics, cosmology, and technology, including:

**Relativity of Simultaneity:** Events that appear simultaneous to one observer may not be simultaneous for another moving at a different velocity. Consequently, there is no universal or absolute “now”; only frame-dependent observations carry meaning [Ryder, 2009, See Chapter 2, Section 2.5: "Simultaneity", 26-28].

**Time Dilation:** Moving clocks tick more slowly than stationary ones [Hafele, 1972, Vol. 177, No. 4044, page 168-170]. Einstein illustrates this through the “light-clock” thought experiment: a photon bouncing between two mirrors. For a stationary observer, the photon travels vertically, while for a moving observer, it traces a diagonal path- a longer distance. Since the speed of light remains constant, the moving clock must tick slower.

General relativity extends these principles to include gravity. It unifies space and time into a dynamic four-dimensional continuum in which mass and energy determine curvature, and curvature dictates motion [Carrol, 2019, 8]. This theory introduces profound implications for the nature of time:

**The Fourth Dimension:** Time forms an inseparable fourth dimension fused with the three dimensions of space, creating a flexible fabric known as "spacetime". Within this structure, a world line represents an object's complete history. Time is no longer an absolute, external flow but a dynamic dimension shaped by matter and energy.

This conception contrasts sharply with Bergson's qualitative, intuitive notion of temporal flow. Einstein envisions the universe as a "four-dimensional block", where past, present, and future coexist and are equally real. Our sequential experience of events arises from perceptual limitations. The apparent passage of time is thus a subjective feature of consciousness moving along a worldline within this static block [Rickles, 2016, See Chapter 4, Section 4.3]. This view directly challenges Bergson's "presentism".

Gravitational Time Dilation: Clocks tick more slowly in stronger gravitational fields [Hartle, 2003, See Section 6.3, 113-121]. For instance, the operation of satellite-based GPS systems must include corrections for this effect—approximately 38 microseconds per day [Ashby, 2003, 15]. Near a black hole, time almost halts; at the event horizon, dilation becomes infinite, so that, for an external observer, an infalling object appears frozen at the boundary.

Einstein maintained that discussions of "subjective time" or "qualitative temporal experience"- what Bergson called "durée"- belong to philosophy, not physics. Physics, he argued, concerns itself exclusively with time as an objective, measurable quantity.

### The Basis of Einstein's Argument

Understanding Einstein's argument requires situating it within its historical and scientific context. In a 1955 letter to the family of his late friend Michele Besso, Einstein wrote:

> Now he [Besso] has departed from this strange world a little ahead of me. That means nothing. For us believing physicists, the distinction between past, present, and future is only a stubbornly persistent illusion [Shenker, 1972, 20].

This idea- that time is an "illusion"- captures the philosophical implications of the theory of relativity and directly addresses philosophers such as Henri Bergson, who challenged Einstein's interpretation. Einstein's claim about the illusory nature of time arises from the core conclusions of special and general relativity: the absence of absolute simultaneity, the four-dimensional "block universe," and the treatment of time as a dimension of spacetime.

When Einstein referred to an "illusion", he did not mean that time is unreal. Rather, he denied the "illusion of temporal passage", the subjective sense of time flowing from past to future and the belief in an absolute distinction between them. In the objective, physical world, all moments coexist equally. The concept of a universal "now" encompassing the entire cosmos has no meaning within relativity. Real time, for Einstein, is the time represented in the equations of physics, not the qualitative, lived flow of inner experience.

Einstein believed that physics reveals the ultimate structure of reality, whereas subjective temporal experience is merely a perceptual approximation- often misleading- of that structure. Consequently, any philosophical theory grounded in subjective temporal experience and claiming to describe objective physical reality is, in his view, based on an illusion.

At the foundation of Einstein's argument, and of the broader "positivist–scientistic worldview" dominant in modern physics, lies the principle of "objectivity" and "verifiability". Einstein, like most empirically oriented scientists, worked within this epistemological tradition, which holds that a claim is meaningful only if it meets two criteria:

1. Objectivity: It must be independent of the observer's mental state; identical conditions must yield identical results for all observers.
2. Testability: It must be confirmable or refutable through experiment or observation. Non-observable or non-measurable concepts are excluded from science.

Einstein's theory of relativity exemplifies these principles. From his standpoint, the central problem with philosophical conceptions of time such as Bergson's lies in their lack of objectivity and testability. The "duration" (durée) of subjective experience is private and incommensurable; no one can measure or compare another's lived experience of time. It cannot be captured by experiment, observed through telescopes, or detected by particle accelerators. Consequently, Bergson's notion of "real time" is not empirically falsifiable and thus, in Einstein's view, lies outside the boundaries of science. Such claims may have poetic or existential value, but they cannot make assertions about the objective structure of the physical world.

If a claim cannot, even in principle, be empirically tested, its truth value cannot be determined, placing it outside the domain of science. From a logical positivist standpoint, such metaphysical propositions are considered "meaningless" because no empirical method exists to verify them [Carnap, 1959, 60-81]

Philosophers, however, have long challenged this critique. Their responses focus on two main issues: "scientific reductionism" and "the presuppositions of science itself". They argue that Einstein's position- and scientism more broadly- reduces all of reality to "measurable physical reality", dismissing other modes of existence such as consciousness, meaning, and subjective experience. These phenomena, though not quantifiable, are nonetheless real. Thomas Nagel, for instance, argues that subjective experience constitutes an irreducible aspect of reality that physical science cannot fully explain [Nagel, 1974, See 435-450].

Moreover, science itself rests upon philosophical assumptions—the objectivity of the external world, the comprehensibility of nature, and the principle of causality—that are not empirically verifiable. These presuppositions are inherently philosophical. As Karl Popper notes, even falsifiability itself relies on unprovable conjectures [Popper, 2002, 33-65]. Therefore, science cannot completely sever its dependence on philosophy.

## Quantum Physics and the New Properties of Time

Time in quantum mechanics presents profound conceptual challenges that diverge sharply from its role in both classical and relativistic physics. In general relativity, spacetime is continuous, dynamic, and deterministic: given the distribution of matter and energy, the geometry of spacetime- and hence the causal structure of events- is fully determined. By contrast, quantum mechanics introduces indeterminacy, discontinuities, and measurement-dependent phenomena that disrupt this deterministic view.

The temporal evolution of a quantum system is governed by the Schrödinger equation, which is linear, continuous, and reversible. If left undisturbed, a quantum state evolves smoothly in time according to this equation. However, measurement introduces an abrupt and fundamentally unpredictable change known as the "collapse of the wave function". This collapse breaks the continuity of evolution and replaces deterministic progression with probabilistic transition. As a result, the act of measurement generates an intrinsic temporal asymmetry- a direction of time not present in the underlying dynamical laws [Guerlin, 2007].

This irreversibility is reinforced by the "no-cloning theorem", which forbids the creation of an identical copy of an unknown quantum state. Because a measurement both disturbs the system and prevents perfect reconstruction of its prior state, the evolution of information in the quantum domain is fundamentally one-way [Barnum, 1996].

In non-relativistic quantum mechanics, time occupies a unique and somewhat paradoxical status. It functions as an external classical parameter that orders the evolution of states, rather than as a quantum observable subject to measurement and uncertainty. Whereas position and momentum correspond to operators acting on a Hilbert space, there exists no self-adjoint time operator, as established by the Pauli theorem [Busch, 2008, 73-105]. Consequently, time in standard quantum mechanics is not quantized; it is an external variable rather than an internal element of the quantum formalism.

This distinction also affects the time–energy uncertainty relation, which differs fundamentally from the position–momentum uncertainty principle. The latter expresses intrinsic limits between two observables represented by non-commuting operators, while the time–energy relation reflects constraints on measurement duration and energy precision rather than a commutation property. Thus, in quantum theory, time remains an open conceptual frontier; half classical and half quantum, resisting assimilation into the same formal status as other physical quantities.

## The Time-Energy Uncertainty Principle

The Heisenberg uncertainty principle stands as one of the cornerstones of quantum mechanics, articulating fundamental limits on the simultaneous determination of certain pairs of physical quantities. Most famously, it asserts that the position and momentum of a particle cannot be known with arbitrary precision at the same time. While the position–

momentum uncertainty relation is the most widely discussed, an analogous relation applies to time and energy; though it differs significantly in both formulation and interpretation.

The position–momentum relation concerns two conjugate observables, each represented by self-adjoint operators whose non-commutation leads directly to the uncertainty relation. These quantities are intrinsic to the system, and the uncertainty expresses a fundamental feature of reality rather than a technical limitation.

In contrast, the time–energy uncertainty relation is conceptually distinct. It does not concern two measurable observables but rather reflects a limitation on how precisely energy can be defined over a given "time interval". Since time in standard quantum mechanics is not represented by an operator but instead serves as an external classical parameter, this relation is not derived from operator commutation but from dynamical constraints on state evolution [Busch, 2008, 73-105].

This distinction has deep implications. If uncertainty exists in time itself, the very notion of "simultaneity" becomes ambiguous and lose its general meaning. Relativity had already shown that simultaneity is not absolute but depends on the observer's frame of reference. Quantum mechanics extends this ambiguity further: even within a single reference frame, the precision of temporal definition is limited by the probabilistic nature of measurement. Thus, while relativity abolishes universal simultaneity across observers, quantum theory undermines its exactness within any single observer's domain.

In this sense, quantum mechanics reveals new "structural properties of time", fundamentally different from those implied by classical or relativistic physics. Revisiting the Einstein–Bergson debate through this lens reorients the discussion: time can no longer be regarded solely as either a psychological flow (Bergson) or a geometric coordinate (Einstein), but as a quantity whose very definition depends on probabilistic and operational limits intrinsic to quantum reality.

## Implications of Time Uncertainty and the Einstein-Bergson Debate in the Quantum Context

The inability to measure a quantum system's energy at an infinitely precise instant, and conversely, to define an exact moment corresponding to a given energy value, introduces profound conceptual challenges for both physics and philosophy. These challenges reshape long-standing metaphysical assumptions about causality, temporal order, and the nature of reality. Several major implications arise:

**1. Weakening of Causality and Definite Temporal Order**

Causality presupposes a definite sequence of events. Yet, if two events cannot be temporally distinguished within intervals shorter than the Planck scale, can one meaningfully assert that one precedes the other? At sufficiently small scales, the notions of "before" and "after" lose clear meaning, destabilizing metaphysical frameworks such as Kantian causality. Causality may thus be reinterpreted not as a universal law but as an emergent property that becomes well-defined only at macroscopic scales.

**2. Challenge to the Ontology of "the Present" and the Passage of Time**

Our phenomenological experience is anchored in the "moment of now." However, if time itself is fundamentally indeterminate, the concept of the present moment loses its ontological precision. This indeterminacy lends support to the Eternalist position in the philosophy of time, according to which past, present, and future coexist within a single structure, and the flow of time is a psychological illusion. Time uncertainty thereby reinforces the view that temporal passage is not a fundamental feature of the universe, but an emergent phenomenon arising from quantum processes at larger scales [Gemsheim, 2023].

**3. Refutation of Time as a Fixed Background**

In classical and relativistic physics, as well as in standard quantum mechanics, time functions as a fixed and universal backdrop for all events. Time uncertainty challenges this notion, suggesting a relational ontology of time: it is not an independent entity but a property that emerges from the interrelations among physical processes. This perspective revives the relational ideas of Leibniz and Mach, and finds rigorous expression in modern quantum gravity frameworks [Rovelli, 2018, 105-115].

**4. Redefining Objective Reality**

If time- the substratum of all events- is itself uncertain, can we still speak of an "objective reality" independent of the observer? This question generalizes the quantum measurement problem, implying that the properties of the world are not absolutely defined but become meaningful only within specific interactions or relational contexts. The boundary between ontology and epistemology thus becomes increasingly blurred [Müller, 2017].

**5. Weakening of the "Moment" Concept**

The uncertainty principle implies that a perfectly defined, isolated "instant" is physically meaningless. Time measurement at the quantum scale is inherently ambiguous, undermining the idea of discrete, point-like moments [Lombardi, 2022]. This resonates with Bergson's critique of the "spatialized" conception of time and partially vindicates his claim that real time cannot be decomposed into atomistic units. Even in physics, time appears not as a continuum of distinct instants but as an indivisible, context-dependent continuum, indicating limits to the relativistic notion of smooth temporal structure.

**6. Duration, Interval, and the Return of Durée**

Although Δt in the time–energy relation is not an operator, it signifies that time at the most fundamental level lacks static, deterministic character. Quantum time is "fuzzy," aligning less with Einstein's deterministic block universe and more- though not identically- with Bergson's durée, the continuous, indivisible flow of becoming. The uncertainty principle highlights the "interval", not the instant, as the meaningful unit of temporal reality, reinforcing Bergson's view that genuine time is defined by continuity and extension rather than by isolated points.

**7. Quantum Vacuum Fluctuations and Creative Temporality**

At extremely short intervals (on the order of Planck time), the uncertainty principle allows temporary energy fluctuations to arise from "nothing," provided they annihilate within the allowed temporal window ['t Hooft, 2021]. This mechanism underlies virtual particle creation, where transient particle–antiparticle pairs momentarily emerge and vanish within the quantum vacuum [Hugon, 2024]. Such spontaneous creation and destruction within time's fabric echo Bergson's notion of creative evolution, suggesting that even the quantum world embodies a form of temporal creativity and indeterminacy—an open, generative process rather than a predetermined one.

Taken together, these insights suggest that time uncertainty fundamentally reshapes our conception of the universe. It undermines classical notions of causality, temporal passage, and objective reality, compelling us to view the cosmos not as something evolving "in" time, but as a "network of interrelated processes" from which time itself emerges as an approximation. In this sense, quantum physics may represent the most profound conceptual revolution since Copernicus and Einstein, transforming our very understanding of existence.

## Synthesis and Apparent Dissonance

At first glance, the quantum properties of time appear to lend unexpected support to Bergson's qualitative conception. Yet, upon closer examination, a fundamental divergence becomes evident (see Table 1). Despite their superficial resonance, the philosophical distance between them remains profound and ultimately irreconcilable.

The key issue lies in the fact that the energy–time uncertainty principle remains a quantitative formulation concerning measurable physical time; that is, quantum time is still a form of "clock time", not Bergson's qualitative durée. The parallel between quantum indeterminacy and Bergson's flowing time exists only at an abstract level, emerging primarily from their shared tension with the deterministic framework of relativity. Quantum time bears no direct relation to the qualitative, experiential temporality that lies at the core of Bergson's philosophy.

In quantum mechanics, uncertainty is objective and mathematical, expressed through formal relations limiting measurement precision. By contrast, Bergsonian durée is subjective and qualitative, describing the indivisible continuity of lived experience. Thus, the energy–time uncertainty relation neither confirms nor refutes Bergson's conception. Rather, it demonstrates that modern physics has evolved toward a more intricate view of time; one that undermines the overly mechanistic model Bergson criticized, without endorsing his phenomenological account.

In short, Einstein and Bergson continue to speak distinct conceptual languages, each addressing a different stratum of reality. Their convergence lies solely in the rejection of a simplistic, mechanistic temporality. Quantum theory reveals that even within physics, time resists reduction to a series of discrete, homogeneous points. This development opens intellectual space for rethinking the ontology of time in more complex and nuanced ways.

In that sense, quantum physics weakens Einstein's position more than it validates Bergson's; its trajectory aligns more closely with Bergson's critical stance than with Einstein's classical and relativistic framework.

**Table 1**. *Fundamental distinctions between Bergsonian durée and quantum time uncertainty*

| Feature | Bergson's *Durée* | Time-Energy Uncertainty Principle |
|---|---|---|
| **Level of Analysis** | Metaphysical & Phenomenological: concerns subjective experience and consciousness. | Physical & Objective: concerns measurable quantities in physical systems. |
| **Nature of Uncertainty** | Qualitative and subjective: uncertainty arises from the continuous flow of consciousness and the fusion of past with present. | Quantitative and mathematical: a formal limit on measurement precision, expressed through equations. |
| **Role of Observer** | The observer is the conscious subject participating in the flow of durée. | The observer is an external measuring apparatus that influences the system (e.g., Copenhagen interpretation). |
| **Aim** | To understand time as the essence of life and consciousness. | To predict and quantify outcomes of physical measurements and experiments. |

## Emergent Time

Both relativity and quantum theory are scientific frameworks grounded in measurement, yet time itself is a concept and quantity that exists independently of any theoretical formulation. A unified understanding of time should therefore, in principle, be attainable. This does not mean that relativity and quantum theory refer to different kinds of time, but rather that they provide incompatible descriptions of it.

In relativity, time forms part of a flexible, dynamic spacetime that is curved by matter and energy, it is not a fixed background parameter but a dynamical field. In contrast, in standard quantum mechanics, time is treated as an external, absolute parameter in the Schrödinger equation, against which quantum systems evolve. The central aim of unifying frameworks such as quantum gravity is to reconcile this tension. Yet, despite decades of research, no definitive resolution has been reached.

When quantum mechanics is combined with general relativity, the very notion of time becomes ambiguous. In certain formulations, most notably in the Wheeler–DeWitt equation [Rovelli & Vidotto, 2022], time disappears entirely from the fundamental equations. This has led to the concept of emergent time, according to which time is not a fundamental entity but arises from correlations among quantum variables or from thermodynamic processes. In this view, time lacks physical substantiality [Vidotto, 2024]. However, because quantum gravity remains an incomplete framework, its ultimate verdict on time's nature is still unknown.

Among the major efforts to unify relativity and quantum mechanics, *Loop Quantum Gravity* (LQG)[1] occupies a prominent place. Within LQG, two of its leading architects, Carlo Rovelli and Lee Smolin, offer sharply contrasting conceptions of time.

### Carlo Rovelli and the "Disappearance of Time":

Rovelli, one of the principal founders of LQG, proposes that spacetime is fundamentally discrete, composed of elementary "quanta" of geometry. At the Planck scale ($10^{-43}$ s), the very notion of time vanishes. Rovelli advocates a "relational" framework in which time is not fundamental but emerges from interactions among events. The world, he argues, should be conceived not as a collection of objects situated in spacetime but as a network of events related causally to one another [Rovelli, 2018]. Time, in this account, is a secondary and approximate concept, much like temperature, a macroscopic property with no meaning at the microscopic level. Its apparent flow and direction arise from entropy increase and from the observer's epistemic limitations. Rovelli's position thus extends Einstein's "block universe" view into the quantum domain, emphasizing its relational and informational aspects.

### Lee Smolin and the "Return of Time":

In contrast, Smolin, a co-founder of LQG, defends the reality and fundamentality of temporal flow. He argues that the static, timeless block universe of Einstein and Rovelli fails to explain why the universe exists or why the laws of physics take their particular form. In a timeless world, genuine causation, novelty, and choice would be impossible. Smolin maintains that time is real and that everything, including the laws of physics themselves, may evolve over time. He envisions a hierarchy of levels in which laws at one level can change through causal processes at a deeper level [Smolin, 2013, 126, 130-135, 257]. This concept of "evolving physical laws" positions Smolin's view closer to Bergson's than perhaps that of any other contemporary physicist. His emphasis on real temporal flow, creative evolution, and the irreversibility of becoming resonates strongly with Bergson's "élan vital", articulated here in the language of theoretical physics. Smolin explicitly praises Bergson for defending the reality of time [Smolin, 2014].

[1]. Loop Quantum Gravity (LQG) is a theoretical framework that seeks to describe the nature of space and time at the smallest possible scales. LQG posits that spacetime itself is composed of discrete, interconnected units known as the "quantum foam," akin to a fabric woven from interwoven loops.

## Contemporary Views

Advances in both science and philosophy have deepened and refined our understanding of time's structure and properties, yet its ultimate nature remains elusive. A survey of contemporary thinkers reveals persistent divergence rather than consensus.

**Tim Maudlin** defends "temporal realism", asserting that the passage and direction of time are fundamental, objective features of reality, not mere psychological or thermodynamic byproducts. He distinguishes between temporal structure (relations among moments) and temporal passage (the dynamic unfolding of reality). As he states:

> The fundamental laws of physics are laws of temporal evolution; they describe how the states of the world change with time. But the passage of time itself is not described by any law; it is a precondition for the existence of laws of evolution. [Maudlin, 2007, p. 109].

**David Albert** explores the "arrow of time" and argues that its directionality is emergent, rooted in the universe's initial low-entropy boundary conditions rather than in the dynamical laws themselves. In "Time and Chance", he writes:

"The real problem of the arrow of time is not that we don't know which way it points, but that we don't know what it is we know when we know which way it points." [Albert, 2000, p. 126]

**Christopher Isham,** a pioneer in quantum gravity, emphasizes the problem of time within that framework. He observes that in general relativity, time is part of the dynamical system, whereas in quantum theory, it is external; an incompatibility that marks one of the deepest conflicts between the two theories. Isham states:

> The problem of time is that in general relativity, time is part of the dynamical system, whereas in quantum theory, time is external... This is a deep and fundamental conflict between our two best physical theories [Isham, 1993, 157-166].

**Huw Price** champions the "temporal neutrality" or "block universe" perspective, contending that the flow of time is an illusion and that past, present, and future is equally real. He further argues that the illusion of temporal passage may have had evolutionary advantages:

> The flow of time is an illusion... We need to explain why we seem to have a view of the world that the world itself does not seem to have. [Price, 1996, p. 14].

**David Chalmers,** though primarily concerned with consciousness, underscores the centrality of temporal experience. He maintains that any satisfactory theory of consciousness must ultimately account for the "structure of temporal experience":

> Temporal experience is one of the most central aspects of consciousness... Any satisfactory theory of consciousness must ultimately explain the structure of our temporal experience. [Chalmers, 1996, 24-50].

Collectively, these perspectives show that the nature of time remains one of the most profound and contested problems in both physics and philosophy. Whether conceived as emergent, fundamental, or illusory, time continues to resist any final or unified interpretation.

## Discussion and Conclusion

Einstein's famous claim that "the time of the philosophers is an illusion" remains among the most provocative in the history of science. Yet, as the perspectives of Rovelli and Smolin demonstrate, even at the frontiers of modern physics the nature of time continues to resist definitive characterization. The problem of time has evolved from a dispute between physics and philosophy into a shared enigma whose resolution may ultimately depend on their synthesis.

The analysis of the time–energy uncertainty principle reveals that modern physics not only fails to close this gap but, in many ways, deepens it. Were the Einstein–Bergson debate to be revisited today, Einstein and Rovelli would likely emphasize the "relational and objective" structure of time, while Rovelli would further argue for its disappearance at the most fundamental scale. Conversely, Smolin and Bergson would defend the "reality and creative flow" of time, although Smolin formulates this within a physical framework rather than a metaphysical one.

The Heisenberg uncertainty principle can be interpreted as lending partial support to both camps. Its intrinsic indeterminacy introduces openness and dynamism at the fundamental level- resonating with Smolin's and Bergson's insistence on novelty and becoming- yet it also reinforces the relational and contextual nature of observation, aligning with Rovelli's and Einstein's perspectives. Quantum theory, therefore, does not resolve the debate but recalibrates it: a century ago, the balance inclined toward Einstein's mechanistic view; today, it has shifted toward Bergson's intuition of creative temporality. The truth, perhaps, lies not in choosing between them but in recognizing the dialectical complementarity of both—time as simultaneously a relational emergent structure and a genuine creative flow. Possessing a relational structure need not contradict the experience of temporal passage.

From a strictly physical standpoint, the "now" has no special status; what matters are the objective properties and interactions that determine a system's evolution. These properties are observer-independent. Einstein's framework, therefore, describes time from the perspective of measurement, not from the nature of its experience. Bergson, in contrast, investigates the "qualitative" and "experiential" aspect of temporal becoming. Both address different facets of the same phenomenon: the measurable and the lived.

The uncertainty principle suggests that physical and philosophical time, though apparently distinct, may share a deeper common essence. Their difference lies in orientation, physics examines the "phenomenon-centered" dimension of time, while philosophy approaches it from the "human-centered" dimension of consciousness. Yet these perspectives might ultimately converge upon the same underlying reality. History offers analogies: before Newton, "force" was a qualitative notion tied to human effort; Newton quantified it. Similarly, "energy" was once an intuitive concept until Joule rendered it measurable. A comparable unification may await the concept of time, where advances in relativity, quantum mechanics, and neuroscience could collectively enable the "quantification of qualitative duration", integrating Bergson's durée with physical time.

If contemporary physics assumes a "Unique and single" time, then the times of Bergson, Einstein, and quantum theory may represent different manifestations of one reality whose complete nature remains only partially known. Yet an alternative possibility arises: can time itself admits multiple, distinct varieties? Properties in nature often exhibit different varieties; for instance, electric charge has positive and negative types, and energy exists in various forms. Yet time, both physically and philosophically, has always been conceived as a unitary concept, perhaps because time (since Newton's era) has been taken for granted alongside space. However, investigating the possibility that time might also have different, hitherto unrecognized varieties could be both intriguing and enlightening.

To conclude this inquiry would be premature, for doing so would close one of humanity's most profound intellectual adventures. A complete comprehension of time may remain beyond our current reach, but the pursuit of that understanding continues to lead us toward the deepest foundations of reality.

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