

True Duration and Divine Presence: Isaac Newton's Theory of Time Reconstructed from Primary Sources

Thesis

Newton's theory of time was not a naive belief in ordinary clock-time, nor was it simply the assumption that the universe ticks forward at an even rate that any good watch can verify. It was a mathematical, metaphysical, and theological doctrine of true duration: an absolute order of succession that flows uniformly *of itself*, exists entirely independently of motion and perception, is only imperfectly and approximately measured by clocks and celestial cycles, and is ultimately grounded in God's eternal and omnipresent mode of existence. The common trope of Newtonian time as a cosmic clock — a universal, observable, mechanical ticker against which events are stamped — obscures the depth, the strangeness, and the genuine philosophical vulnerability of Newton's actual view. His theory is simultaneously more ambitious and more fragile than the textbook image suggests: more ambitious because it posits a metaphysical reality that no instrument can directly reach, and more fragile because it rests on commitments — to divine omnipresence, to the coherence of a flow independent of all change, to the existence of a "true" quantity behind every sensible measure — that later physics and philosophy would dismantle from several directions at once.

Part One: Primary Sources and the Architecture of the Scholium

The Scholium to the Definitions: What Newton Actually Wrote

The most important document for understanding Newton's view of time is not any popular summary or secondary exposition. It is the *Scholium to the Definitions* in Book I of the *Philosophiæ Naturalis Principia Mathematica* (first published 1687, with significant revisions in 1713 and 1726). Newton prefaces this section by announcing something disarming: he will not *define* time, space, place, and motion, since these are "well known to all." But the move that follows this disclaimer is far from casual. He observes that "the common people conceive those quantities under no other notions but from the relation they bear to sensible objects. And thence arise certain prejudices, for the removing of which it will be convenient to distinguish them into absolute and relative, true and apparent, mathematical and common."

The word "prejudices" (*præjudicia* in Latin) is precisely chosen. Newton is not merely making a technical distinction between ideal and practical time; he is diagnosing a cognitive error — a systematic conflation of the measured thing with the thing itself — and he is offering a corrective. The entire architecture of the Scholium rests on the claim that popular usage systematically mistakes sensible measures for the underlying quantities. This is why the distinction matters philosophically and not merely instrumentally.

The key passage, given in the Motte-Cajori translation (1729/1934), reads:

"Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external, and by another name is called duration: relative, apparent, and common time, is some sensible and external (whether accurate or unequable) measure of duration by the means of motion, which is commonly used instead of true time; such as an hour, a day, a month, a year."

The Cohen-Whitman translation (1999), now the standard scholarly edition, renders the opening clause as: "Absolute, true, and mathematical time, in and of itself and of its own nature, without reference to anything external, flows uniformly and by another name is called duration." The differences are instructive. Where Motte-Cajori writes "flows equably," Cohen-Whitman writes "flows uniformly." Both translate *aequabiliter*, a Latin adverb meaning evenly or uniformly, but "equably" sounds archaic and metaphorical while "uniformly" sounds more like a mathematical property. The substantive meaning is the same — that absolute time does not speed up, slow down, or vary in its rate of passage — but the register shifts between a quasi-animate "flowing" and a more arid mathematical regularity. Neither translation resolves the underlying philosophical question of what it means for time to "flow" at all, given that any rate of flow would seem to require a second temporal standard against which to measure the first.

The Latin original — *Tempus absolutum, verum, et mathematicum, in se et natura sua absque relatione ad externum quodvis, aequabiliter fluit, alioque nomine dicitur Duratio* — is worth attending to phrase by phrase. *In se et natura sua* means "in itself and by its own nature": Newton is asserting that the equable flow is intrinsic to time, not dependent on any external standard or cause. *Absque relatione ad externum quodvis* means "without relation to anything external whatsoever." This phrase does enormous philosophical work. It tells us that absolute time does not depend on the existence of matter, on the motions of the planets, on the operation of clocks, on the experience of conscious observers, or on any other contingent feature of the created world. It is self-subsistent.

Aequabiliter fluit — "flows equably" or "flows uniformly" — has attracted sustained philosophical attention. For time to "flow" already seems to presuppose a temporal dimension within which the flowing occurs, which generates a regress. Newton was aware of this difficulty but chose to speak of duration rather than resolve it: his strategy is to treat the equable flow of absolute time as a *postulate*, a foundational posit of his mechanics, rather than a derived result. The word *duratio* (duration) is Newton's term for the intrinsic being of absolute time — its sheer persisting or continuing, independent of any change in the world.

Relative, apparent, and common time, by contrast, is defined as "some sensible and external (whether accurate or unequable) measure of duration by the means of motion." The parenthetical "(whether accurate or unequable)" is significant: Newton concedes that some relative measures of time may be more accurate than others, but even the most accurate relative measure remains a *measure of duration* rather than duration itself. Hours, days, months, and years are listed explicitly as examples of relative time. Not one of them is identified with true time.

The Astronomy of Time: On the Inequality of Natural Days

Section V of the Scholium extends the argument from an astronomical direction:

"Absolute time, in astronomy, is distinguished from relative, by the equation or correction of the apparent time. For the natural days are truly unequal, though they are commonly considered as equal, and used for a measure of time; astronomers correct this inequality that they may measure the celestial motions by a more accurate time."

This passage demolishes the popular assumption that Newton's absolute time was simply identified with the regular passage of celestial cycles. Newton knew — as any competent astronomer of his era knew — that the solar day varies in length throughout the year because of the eccentricity of Earth's orbit and the obliquity of the ecliptic. The "equation of time" was the astronomers' correction factor by which apparent solar time was adjusted to yield mean solar time. Newton's point is that this correction already presupposes a truer time against which the solar day is being judged unequal. The astronomer corrects by appeal to something more regular than the sun; but can we be certain that any physical process is perfectly regular?

Newton's answer is striking and philosophically audacious:

"It may be, that there is no such thing as an equable motion, whereby time may be accurately measured. All motions may be accelerated and retarded, but the flowing of absolute time is not liable to any change. The duration or perseverance of the existence of things remains the same, whether the motions are swift or slow, or none at all: and therefore this duration ought to be distinguished from what are only sensible measures thereof."

This is not the language of someone who believes that clock-time or planetary motion constitutes time. Newton is explicitly saying that it may be physically impossible to find any motion that perfectly measures absolute time. No clock, no pendulum, no orbital period, no astronomical cycle is guaranteed to be equable. They may all deviate from true time, and none of them can serve as an infallible index of it. Absolute time is, in principle, beyond the reach of any physical instrument. The "equation" used by astronomers — derived from the theory of the solar system — is an *approximation* to true time, not its revelation.

The phrase "the duration or perseverance of the existence of things remains the same, whether the motions are swift or slow, or none at all" is Newton's clearest statement that absolute time flows even in the absence of change. If every motion in the universe were to be simultaneously halted — a thought experiment Newton does not pursue but which his position entails — time would still pass. Duration is the sheer being-in-time of things, not the enumeration of changes.

Section VI: Immutability of Order and the Structural Analogy with Space

Section VI of the Scholium draws the parallel between time and space that defines Newton's metaphysical picture:

"As the order of the parts of time is immutable, so also is the order of the parts of space. Suppose those parts to be moved out of their places, and they will be moved (if the expression may be allowed) out of themselves. For times and spaces are, as it were, the places as well of themselves as of all other things. All things are placed in time as to order of succession; and in space as to order of situation. It is from their essence or nature that they are places; and that the primary places of things should be movable, is absurd."

The structural analogy here is precise and important. Just as no region of absolute space can be moved to a different location in space (for space is not itself in space), so no moment of time can be moved to a different position in time. The order of succession of temporal parts is immutable — prior and posterior moments cannot be rearranged without absurdity. This is not merely a grammatical point but an ontological one: time has a structure of succession that is intrinsic to what it is, and this structure is fixed absolutely, not relative to any particular observer or physical system.

The phrase "All things are placed in time as to order of succession; and in space as to order of situation" is Newton's account of what time and space *do*: they are the containers (or frameworks, or conditions) within which all events and things are located. The order of succession in time is absolute — event A either occurs before, simultaneously with, or after event B, and this relation does not vary across observers or reference frames. This is exactly the feature that Einstein's special relativity would later abolish: for Newton, simultaneity is a fact of absolute time; for Einstein, it is frame-dependent.

Part Two: Absolute Time and Relative Time — A Precise Account

The Triads and Their Relationship

Newton employs two triads: "absolute, true, mathematical" on one side, and "relative, apparent, common" on the other. These three adjectives in each triad are not synonyms chosen for rhetorical effect; they emphasize different aspects of the same distinction.

Absolute versus *relative* marks the ontological divide: absolute time exists independently of any relationship to material things or observers, while relative time is defined by reference to motions (celestial, mechanical, or otherwise). *True* versus *apparent* marks the epistemological divide: true time is what actually passes, while apparent time is what is revealed to the senses through observable motions, which may deviate from true time. *Mathematical* versus *common* marks the scientific divide: mathematical time is the ideal, perfectly uniform parameter that enters Newton's equations of motion, while common time is what ordinary people use — hours, days, years — as a practical guide.

The relationship between these two sides is not one of identity but of *approximation and measure*. Relative, apparent, common time is what we use "instead of" true time. It is a stand-in that, in practice, serves reasonably well for everyday affairs. But in "philosophical disquisitions," Newton insists, "we ought to abstract from our senses, and consider things themselves, distinct from what are only sensible measures of them."

This is an empiricist's move turned against naive empiricism. Newton appeals to the distinction between theory and observation: the physicist's equations require a perfectly uniform time-parameter, and this parameter is not identical to any observable physical process. The observable processes are evidence for and proxies of the mathematical time in the equations, but the parameter itself is ideal. In this way, Newton's absolute time functions similarly to the way idealized quantities function in all of physics — the perfectly rigid body, the frictionless plane, the point mass. These idealizations are never realized in nature, but they make the mathematics tractable and the theory powerful.

Duration Without Motion

The most philosophically radical consequence of Newton's position is the claim that time continues even if nothing changes. This follows directly from his insistence that absolute time has no "relation to anything external." If time depended on motion, it would cease or become indeterminate in a motionless universe. Newton explicitly rejects this dependence: duration "remains the same, whether the motions are swift or slow, or none at all."

This puts Newton in direct opposition to Aristotle, for whom time is the "number of motion according to before and after." In Aristotle's *Physics* (Book IV), time is not merely correlated with motion but constituted by it. Time is the number or measure that the soul counts when it perceives a before and an after in motion. Without motion — and, for Aristotle, without a soul to perceive it — there is no time. The Aristotelian position is relational in a strong sense: time is ontologically dependent on the existence of changing things and, arguably, on minds to perceive the change.

Newton reverses this dependence. For him, motion is measured *by* time; time is not constituted *by* motion. This is a revolutionary metaphysical inversion, and it is the foundation of his mechanics. Newton's second law, $F = ma$, requires a time-parameter with respect to which acceleration is defined. If time were merely the order of observed changes, the law would be circular or indeterminate. The "t" in Newton's equations is absolute time — the ideal, uniform parameter that underlies all calculations. Without absolute time, the mathematical structure of classical mechanics collapses.

The question of whether time can flow in a completely empty universe — a universe with no matter, no motion, no events — is one that Newton's position seems to answer affirmatively, and it is a question that continues to exercise philosophers of physics. Relational theories, from Leibniz through Mach to contemporary loop quantum gravity, argue that this is nonsensical: duration is always the duration *of something*. Newton's absolutism insists on the opposite: time is the permanent backdrop, the metaphysical receptacle, within which events occur, and it would continue whether or not any events occurred.

Part Three: Space and Time Together — The Structural Pair

Why Newton Pairs Time and Space

Newton treats time and space as a pair throughout the Scholium. The parallel definitions ("Absolute space, in its own nature, without relation to anything external, remains always similar and immovable") mirror each other precisely. This pairing is not accidental. For Newton, both time and space are necessary to define absolute motion — the key target of the Scholium's argument. The Scholium ultimately aims at establishing that there is a meaningful distinction between true motion and apparent motion, and that the laws of mechanics are laws about true (absolute) motion. Absolute motion requires absolute space (to define true position and displacement) and absolute time (to define true velocity and acceleration). The two are conceptually inseparable in Newton's mechanics.

The bucket experiment is Newton's most famous argument for absolute space. A bucket of water is hung by a cord, twisted, and released. As the bucket rotates, the water's surface at first remains flat (when the bucket rotates but the water does not), then becomes concave (when the water shares the bucket's rotation). Newton's argument is that the concavity of the water's surface — the tendency of the water to recede from the axis of rotation — is a real, physical effect that indicates *true* rotation, not merely rotation relative to some convenient reference body. When the water and bucket rotate together, their relative motion is zero, yet the water is concave; when they are stationary relative to each other (before any motion begins), the water is flat. The concavity is not caused by relative motion between water and bucket but by absolute rotation in absolute space.

This argument provides indirect support for absolute time as well, since the quantification of absolute rotation requires a time-parameter: to say that the water is rotating at such-and-such an angular velocity requires a unit of time. If this time-parameter is relative to some observer or process, the claim that rotation is "truly" absolute becomes incoherent. Absolute time is the necessary complement to absolute space in Newton's defense of true motion.

The Immutability of Temporal Parts and the Rejection of Relationism

Section VI's claim that "the order of the parts of time is immutable" is Newton's most concise ontological statement about temporal structure. It means that the before-after ordering of moments in absolute time is fixed and cannot vary. Two events A and B either occur in the order A-then-B or B-then-A (or simultaneously), and this ordering is not relative to any observer, frame of reference, or physical process. There is one global temporal order, and every event in the universe has a unique temporal position within it.

This is precisely the feature Leibniz denies. For Leibniz, time is nothing over and above the *order of successions* among actual events. There is no temporal structure independent of the events themselves. If there were no events, there would be no time — time is an abstraction from the actual relational structure of the world. Newton's temporal order, for Leibniz, is a fictitious superstructure that violates the principle of sufficient reason (why would time have any particular moment as "now" if all moments are intrinsically indistinguishable?) and the identity of indiscernibles (absolute time that is distinct from relational time involves indistinguishable scenarios — universes shifted forward or backward in absolute time — which should be identical by the identity of indiscernibles).

Newton was aware of the Leibnizian objection in a general form, though the full Leibniz-Clarke correspondence occurred after the Principia. His response, worked out partly through Samuel Clarke (who corresponded with Leibniz in 1715–1716, likely with Newton's direct input), was to hold that the Principle of Sufficient Reason and the Identity of Indiscernibles are not constraints on omnipotent divine action. God can create the universe in one moment of absolute time rather than another without any sufficient reason distinguishing those moments, and this does not require that the moments be identical. The scenarios are intrinsically different even if humanly indistinguishable.

Part Four: God, Eternity, and the Constitution of Duration and Space

The General Scholium's Theological Argument

The General Scholium, added to the second edition of the Principia in 1713, takes Newton's metaphysics of time to its deepest and most theologically explicit level. The key passage, rendered in the Motte translation (1729), reads:

"He is Eternal and Infinite, Omnipotent and Omniscient; that is, his duration reaches from Eternity to Eternity; his presence from Infinity to Infinity; he governs all things, and knows all things that are or can be done. He is not Eternity and Infinity, but Eternal and Infinite; he is not Duration and Space, but he endures and is present. He endures forever, and is every where present; and, by existing always and every where, he constitutes Duration and Space."

The philosophical care of this passage repays close attention. Newton is explicitly denying the identification of God with eternity, infinity, duration, and space. God is not *identical* to these things; he is *not* eternity or duration as such. He is a personal being who *endures* and is *present* — these are attributes or modes of his existence. And his enduring always and being present everywhere is what *constitutes* duration and space.

The word "constitutes" (*constituit* in the Latin) is the philosophical crux. Three interpretive traditions have emerged in Newton scholarship:

1. **Independence:** Space and time are simply independent of God; they exist whether or not God exists, as necessary features of reality. Some philosophers take Newton's denial that God is duration or space to imply that they are separate entities.
2. **Causation:** Space and time are caused or created by God, and depend on his will, though they are distinct from him. On this reading, "constitutes" means something like "brings into being."
3. **Assimilation** (or the attribute view): Space and time are genuine attributes of God — not identical to God, but real properties of his existence, much as Descartes argued that duration, number, and order are the most general attributes of any being. On this reading, "constitutes" means that God's eternal endurance and omnipresence *are* duration and space, in the sense that these metaphysical realities are grounded in and dependent on the divine mode of existence.

The third interpretation has considerable support from the text of the *De Gravitatione*, Newton's unpublished manuscript (probably written before the *Principia*), and from Newton's own unpublished manuscript on space, time, and God prepared for a projected second edition of the *Principia* (now known from J.E. McGuire's 1978 publication of it). In the *De Gravitatione*, Newton argues that space is not a substance (for substances act causally, and space does not), not an accident of substance (for it would exist even with no substances), but rather a kind of entity *sui generis*: an "emanative effect" of God's existence, necessarily following from divine being as a theorem follows from an axiom. Space does not depend on God's will (it cannot be otherwise) but on God's nature. By analogy, absolute time — duration — is the "emanative effect" of God's eternal endurance.

This is the view worked out in the third interpretive tradition. Newton's position is that duration and space are not independent of God, not contingently caused by God, but necessarily dependent on God's mode of existence: they are what God's omnipresence and eternal endurance *look like* to a metaphysician. God does not exist *within* time and space (as creatures do); rather, time and space are constituted by the fact that God exists always and everywhere.

This position has been described by some scholars as panentheism — not pantheism (God is the world), but the view that the world is in some sense "in" or "within" God, while God is more than the world. Newton himself rejected pantheism explicitly: "This Being governs all things, not as the soul of the world, but as Lord over all." God is master and sovereign, not simply the soul or life of the universe. He also explicitly rejects the identification of God with space: God is not Duration or Space but *endures* and is *present*.

The Sensorium Controversy and the Opticks

In the Queries appended to the *Opticks* (especially Query 28, first published in Latin in 1706 as Query 20 of the *Optice*, and Query 31 of the 1718 English edition), Newton employed the term *sensorium* in connection with God:

"Does it not appear from Phaenomena that there is a Being incorporeal, living, intelligent, omnipresent, who in infinite Space, as it were in his Sensory, sees the things themselves intimately, and throughly perceives them, and comprehends them wholly by their immediate presence to himself?"

Leibniz seized on this passage as evidence that Newton was committed to pantheism — that space is literally God's organ of sense, as if God were a great animal perceiving the world through spatial extension. Newton was alarmed by this reading and took steps to clarify, eventually inserting a qualification — "as it were" (*tanquam*) — to signal that the *sensorium* language was analogical, not literal.

Newton's actual point, carefully reconstructed, was an analogy to human perception. In a human being, the soul perceives images in the brain's sensorium through immediate presence. Newton asked whether God's immediate presence to all of space — which he maintained was not virtual but substantial ("God is omnipresent not virtually only, but also substantially") — might be understood by analogy to this. The analogy is not an identity: God is not a brain, and space is not a literal organ. The analogy was intended to illuminate the intimacy and immediacy of God's knowledge and governance of the universe, not to provide a physiology of the divine.

In a manuscript draft for the collection of the Leibniz-Clarke correspondence edited by Des Maizeaux, Newton wrote: "It is a contradiction to tell us that God is every where by his vertue and no where by his substance." God's substantial omnipresence means that there is no part of space where God's being is not present, in a manner that exceeds any merely functional or causal sense. Newton's theology required this to make sense of divine governance: a God who acts everywhere must be present everywhere, and this omnipresence just is what space is constituted by.

The Unpublished Manuscript: De Gravitatione

De Gravitatione et Aequipondio Fluidorum (written in the 1660s or 1670s, and not published until 1962) provides the philosophical scaffolding for the positions Newton would later state more guardedly in the *Principia*. Its treatment of space is the most extended and explicit he ever committed to writing. Newton argues there that space is neither a substance nor an accident of substance but something intermediate — an entity that exists necessarily and independently of the existence of any particular substances, that is *co-eternal* with God, and that cannot be created or destroyed.

The implications for time are not fully worked out in *De Gravitatione* (which focuses primarily on space and on the critique of Descartes' relational definition of motion), but they are strongly suggested by parallel structure. If space is a necessary emanative effect of God's omnipresence, then duration — absolute time — is a necessary emanative effect of God's eternity. Both are infinite, both are real, both are independent of the material world, and both are grounded in divine existence.

The manuscript also contains Newton's crucial distinction between three categories of being: God, space/time (as necessary emanative effects), and finite substances. This three-tier ontology explains why Newton denies that space and time are substances (they do not cause anything) while also denying that they are mere relations among substances (they would exist even with no substances present). They occupy a unique ontological niche — real, necessary, non-substantial, and grounded in the divine.

Part Five: The Four Layers of Newton's Time

A philosophically adequate account of Newton's theory must distinguish four conceptually distinct levels, which Newton himself does not always keep separate but which can be identified through close reading:

1. Mathematical Time. The ideal, perfectly uniform parameter t that appears in Newton's equations of motion. This is the time of the mathematical physicist — an abstract, continuous, one-dimensional ordering with a fixed metric (equal intervals "really" equal). It enters the formulas of the Principia as a given, prior to any discussion of measurement. This is what the equations require; the question of how to measure it is a separate matter.

2. Measured Time. The practically available approximations to true time: hours, days, months, years, the corrections of the astronomical equation, the period of pendulums, the eclipses of Jupiter's satellites. Newton explicitly uses the Jupiter eclipse example in Section V of the Scholium as evidence for the need to correct apparent time. These measured quantities are evidence for, and proxies of, mathematical time, but they are not identical to it. They are reliable to varying degrees, and none is perfectly reliable.

3. Metaphysical Time. Absolute duration — the sheer persisting of the universe in time, independent of all motion and perception. This is what Newton calls "true" time in a metaphysical sense: the actual temporal fact of the universe's existence, prior to and independent of any measurement. This is the aspect of Newton's view that is most distant from empirical science and most difficult to integrate with later positivist reconstructions of mechanics.

4. Theological Time. Duration as constituted by God's eternal endurance. This fourth layer grounds the third: absolute duration is not a brute metaphysical primitive but has its foundation in the manner in which God exists — eternally, always, without beginning or end. The eternity of God is not merely an infinite extension of duration but the ground of duration itself.

These four layers are not fully separable in Newton's texts, and the question of whether they are ultimately coherent is genuine and unresolved. The mathematical and measured layers are clearly coherent with each other (mathematical time is the ideal limit of which measured time is an approximation). The metaphysical and theological layers are coherent with each other on Newton's theological premises (divine eternity grounds absolute duration). The tension is between the first two and the last two: mathematical physics postulates an ideal parameter, but Newton wants this parameter to be a real metaphysical feature of the world grounded in God. He wants the "t" in his equations to not merely be a useful abstraction but to track something genuinely there in the fabric of reality. Whether physics, as such, needs this metaphysical grounding is a question Newton never fully separated from his theological commitments.

Part Six: Ten Myths Corrected

Myth 1: Newton thought time was just what clocks measure.

Newton explicitly and repeatedly denies this. Section V of the Scholium states that "it may be, that there is no such thing as an equable motion, whereby time may be accurately measured. All motions may be accelerated and retarded, but the flowing of absolute time is not liable to any change." No clock — not a pendulum clock, not the rotation of the Earth, not the orbit of Jupiter — can perfectly measure absolute time. They are all fallible approximations.

Myth 2: Newton thought celestial motion creates time.

Newton's position is the direct opposite: "All things are placed in time as to order of succession." Celestial motions are *in* time; time is not constituted by them. The natural days are "truly unequal" even though they are used as measures of time. The astronomer corrects these inequalities precisely because the celestial motions are imperfect measures of an independent standard.

Myth 3: Newton's time is merely common-sense time.

Newton explicitly contrasts absolute, true, mathematical time with common time and warns that to confuse the two is to "defile the purity of mathematical and philosophical truths." Common time (hours, days, years) is the practical substitute for true time in everyday affairs, adequate for common purposes but systematically inadequate for philosophical inquiry.

Myth 4: Newton had no metaphysical or theological theory of time.

The General Scholium's statement that God "by existing always and every where, he constitutes Duration and Space" is a piece of metaphysical theology. The unpublished *De Gravitatione* provides an extended theological and metaphysical argument about the nature of space (and by implication time) as a necessary emanative effect of divine existence. Newton's theory of time is inseparable from his natural theology.

Myth 5: Newton thought absolute time was directly observable.

Newton explicitly says the opposite: "the parts of that immovable space, in which those motions are performed, do by no means come under the observation of our senses." Absolute time and space are, by Newton's own admission, unobservable. We can infer their existence and approximate their metric from observable motions, but we cannot perceive them directly. Absolute time is a theoretical posit, not an observation.

Myth 6: Newton's universe was simply a dead mechanical machine with no divine grounding.

This is perhaps the most entrenched misrepresentation. Newton devoted more manuscript pages to theology than to mathematics and physics combined. He believed that the solar system required periodic divine correction to remain stable. The General Scholium's extended discussion of God as "Lord" who governs all things, and the discussion of God's omnipresence as constituting space, present a universe that is at every moment dependent on divine sustenance and governance. For Newton, the machine metaphor (which he did use) does not exclude but in fact requires a divine machinist who remains immanent in the machine through his omnipresence.

Myth 7: Einstein simply made Newton stupid or obsolete.

Einstein's special relativity showed that Newton's assumption of universal absolute simultaneity — the idea that two events are either simultaneous or not, absolutely, for all observers — is empirically false when velocities approach the speed of light. This is a genuine and important revision. But it does not make Newton "wrong" in any unqualified sense. Within the domain where velocities are small compared to the speed of light, Newton's absolute time is an excellent approximation; classical mechanics remains the workhorse of engineering, celestial mechanics, and everyday physics. Moreover, as the Stanford Encyclopedia of Philosophy notes, "the novel feature of special relativity, the rejection of absolute simultaneity — something that never occurred to any of Newton's earlier critics — necessitated only that absolute space and absolute time be replaced with an absolute space-time (Minkowski spacetime)." Newton's substantivalism about spacetime structure is actually *vindicated* in a different form by Einstein: what Einstein rejected is the particular Newtonian structure (separate absolute space plus separate absolute time), not the commitment to an objective spacetime structure.

Myth 8: Newton's absolute time is the same as the modern idea of spacetime.

Newton's absolute time and Einstein–Minkowski spacetime are different structures. In Newton, time and space are separate and independent; there is a universal simultaneity; time is one-dimensional and universal. In Minkowski spacetime, time and space are fused into a four-dimensional continuum; there is no universal simultaneity; time intervals between events are frame-dependent (though the spacetime interval is invariant). Newton's "t" is a global parameter; in relativity, there is no global "t" that all observers agree on.

Myth 9: Newton believed time and space are literally God.

Newton is explicit: "He is not Eternity and Infinity, but Eternal and Infinite; he is not Duration and Space, but he endures and is present." God is a living, intelligent, powerful being who *has* the properties of eternal endurance and omnipresence; God is not identical to duration and space. The constitutive relationship is one of grounding, not identity.

Myth 10: Newton's "absolute" means empirically accessible rather than mathematically and metaphysically posited.

The word "absolute" in Newton means something closer to *independent* — independent of external relations, independent of particular observers, independent of particular physical processes. It does not mean directly measurable or directly perceivable. Newton himself acknowledges that it is "a matter of great difficulty to discover, and effectually to distinguish, the true motions of particular bodies from the apparent." Absolute time is precisely the kind of entity that is posited as a condition of the intelligibility of physics, not as a directly observed datum.

Part Seven: Comparative Philosophy of Time

Newton and Aristotle

Aristotle's definition of time in the *Physics* (Book IV) — time is "the number of motion according to the before and after" — makes time essentially dependent on motion. Without motion, there is no time; time is not a container that continues independently. Time also has a perceptual dimension for Aristotle: the soul perceives the before and after in motion, and it is this perception that constitutes the "numbering" that is time. Newton's absolute time is the systematic negation of both dependencies: it does not depend on motion, and it does not depend on any perceiving soul. Duration continues whether or not anything moves and whether or not any mind perceives it.

Newton was aware of the Aristotelian tradition through his study of Descartes, Gassendi, and other early moderns, though he did not engage with Aristotle's *Physics* in the same detailed way he engaged with Descartes's *Principia Philosophiae*. The crucial intermediate figure is Pierre Gassendi, who revived the atomist tradition of infinite, independent space and time and influenced Newton significantly. Like Newton, Gassendi denied that time is the number of motion; like Newton, he insisted that motion is measured by time, not the reverse. Newton's absolute time is in this respect a Christianized, mathematically rigorous version of the Gassendist tradition.

Newton and Leibniz

The Newton-Leibniz debate on time is the defining controversy of early modern metaphysics of time, and it remains philosophically alive today. Leibniz's core claim, expressed in the correspondence with Clarke (Leibniz's Third Paper, 1716): "I hold space to be something merely relative, as time is, that I hold it to be an order of coexistences, as time is an order of successions."

For Leibniz, time is not a container or a metaphysical substance; it is a system of ordering relations among events. Time "exists" only in the sense that the relations of priority, simultaneity, and succession among events exist. There is no "empty" time between events; asking when events occur in absolute time is as meaningless as asking where the center of the universe is in relational space.

Leibniz's arguments against Newton are principally of two kinds. First, the Principle of Sufficient Reason: if the universe had been created at a different moment in absolute time, nothing observable would differ; therefore there is no sufficient reason for God to have created it in one moment rather than another; therefore the distinction is meaningless. Second, the Principle of the Identity of Indiscernibles: two supposedly distinct states of affairs that differ only in their position in absolute time are in fact identical, since no intrinsic difference distinguishes them.

Newton's (and Clarke's) response is to deny that these principles bind God's action: God can act without external sufficient reason, and intrinsic indiscernibility does not imply identity if we allow that temporal position is a genuine intrinsic feature. The debate turns on deep issues about the nature of relations, identity, and divine action that cannot be fully resolved here. What is important is that Newton's position is not naive but rests on a carefully worked-out metaphysical and theological framework, and that Leibniz's relational alternative, though intuitively appealing to modern sensibilities, faced its own difficulties — above all, the problem of inertia and rotation, which Newton's bucket experiment was designed to press.

Newton and Mach

Ernst Mach's *Science of Mechanics* (1883) subjected Newton's absolute time and space to a sustained positivist critique. Mach's basic argument: absolute time is unobservable and therefore scientifically meaningless. The only times we can measure are relations between observable processes. Newton's claim that natural days are unequal presupposes some standard of true equality, but every proposed standard is itself an observable motion, and no non-circular appeal to absolute time is possible.

Mach proposed replacing absolute time with time defined relative to the totality of matter in the universe — what has been called "Mach's principle" for time. Inertial forces (like the centrifugal force in Newton's bucket) are determined not by motion with respect to absolute space and time but by motion with respect to the "fixed stars" (the bulk of the universe's mass). This is an operationalist or instrumentalist move: replace unobservable theoretical entities with observable relations.

Mach's critique is powerful within a positivist framework, but it has its own difficulties. If time is entirely relational, it becomes unclear how to define the rates of physical processes without circularity. Modern physics has shown that Mach's principle, as a positive proposal, is very difficult to implement consistently. General relativity is sometimes described as "Machian" but is not straightforwardly so: it allows solutions (like empty space solutions) that have no reference masses to define an inertial frame.

Newton and Einstein

Einstein's 1905 special relativity is the decisive turning point in the physics of time. Einstein demonstrated that the constancy of the speed of light in all inertial frames (an empirical fact, confirmed by the Michelson-Morley experiment and other tests) is inconsistent with Newton's absolute simultaneity. Two events that are simultaneous in one inertial frame are not simultaneous in another frame moving relative to the first. This is not a matter of measurement error or epistemic limitation; it is a feature of the physical structure of the universe.

Newton's absolute time required a global "now": a universal present moment that all observers share, however distant. Special relativity abolishes this. There is no observer-independent fact about which events are simultaneous. Each inertial observer has a "local" time, and these local times are related by the Lorentz transformations, not the Galilean transformations that Newton's mechanics assumed.

It is crucial, however, to understand what exactly this overturns. It overturns the existence of a *single global time function* that partitions all events into simultaneous classes. It does not overturn the reality or objectivity of temporal relations: events still have a definite causal order (which is absolute in relativity — if A causes B, all observers agree on this), and the spacetime interval between events is observer-independent even if temporal and spatial intervals separately are not. Minkowski's 1908 reformulation showed that special relativity posits an absolute spacetime (four-dimensional, pseudo-Riemannian manifold with Minkowski metric) that is just as "absolute" in Newton's sense — independent of observers, objectively structured — as Newton's separate absolute space and absolute time were. The difference is that Newton's two absolutes are replaced by one.

Newton's theory was also a "limiting case": as velocities approach zero relative to the speed of light, the Lorentz transformations approach the Galilean transformations, and special relativity reproduces all of Newtonian mechanics. Newton was not "wrong" for the domain in which he was working; his mechanics was extraordinarily accurate for all the problems he considered. The failure is only in a regime (velocities near c) that he had no empirical access to and no theoretical reason to consider.

Newton and Minkowski

Minkowski's four-dimensional spacetime is sometimes confused with Newton's framework, as if Newton already believed in a four-dimensional unification of space and time. This is a serious error. For Newton, time and space are *separate* absolutes: time is one-dimensional, space is three-dimensional, and the two are independent. There is a global "now" that slices spacetime into simultaneous three-dimensional spaces. In Minkowski spacetime, by contrast, there is no such global slicing; the "now" is observer-dependent; temporal and spatial separations are mixed by Lorentz boosts; and the fundamental structure is the four-dimensional interval. Newton's time is not Minkowski time in a different notation; they are metaphysically and mathematically distinct.

Part Eight: Is Newton's Position Coherent?

The Internal Tensions

The four layers of Newton's time sit uneasily together in places:

The flow problem. Newton says time "flows equably." But what does it mean for time to flow? A flow is typically a rate of change — velocity is the flow of position over time. But the flow of time itself would seem to require a meta-time over which it flows, generating an infinite regress. Newton does not resolve this; he treats "flows equably" as a primitive description of duration, not susceptible to further analysis. This is either a deep insight (some features of reality cannot be further explained) or a philosophical evasion. Most philosophers today regard temporal flow as one of the most difficult and unresolved problems in the metaphysics of time.

The measurement problem. Newton claims that absolute time may be beyond the reach of any physical measuring instrument. He also insists that we can approximate it through astronomical corrections and pendulum experiments. But if no instrument can exactly measure absolute time, how do we know that our approximations are getting closer to it? What justifies the inference from imperfect measurements to the character of the ideal standard? Newton does not fully answer this; he relies on the coherence of the mathematical framework to vindicate the posit.

The theological grounding. The claim that God's eternal endurance constitutes duration is a theological commitment that sits uneasily with the scientific aspiration to provide a framework applicable without theological premises. Newton himself seems to have thought these were complementary rather than in tension — the natural theology of the *Principia* supported and was supported by the mathematical mechanics. But later physics, from Laplace ("I have no need of that hypothesis") onward, has sought to separate these. The modern physicist uses Newton's mechanics without any reference to divine omnipresence.

The three-tier ontology. Newton's postulation of time and space as neither substances nor accidents of substances (his position in *De Gravitatione*) is metaphysically unstable. If space and time are not substances, they cannot undergo change, enter causal relations, or be acted upon — which is consistent with their role as passive background. But if they are not accidents of substances (properties of things), they seem to float free of all ordinary ontological categories. Newton's appeal to them as "emanative effects" of the divine is his attempt to anchor this ontology, but it depends on the particular theological framework.

What Newton Got Right

Newton's insistence on distinguishing the ideal parameter of mechanics from any particular physical measuring process was a profound methodological insight. Modern physics has vindicated this in a different form: the "coordinate time" or "proper time" of a relativistic system is indeed not identical to any particular clock reading, and the distinction between the mathematical structure of spacetime and its empirical manifestations is standard. Newton was right that physics requires a parameter not reducible to any single physical process, even if the character of that parameter is different from what he imagined.

Newton's rejection of purely relational time was also, in a sense, vindicated. Leibniz's relational program faced intractable difficulties — above all, the inability to account for inertial forces in a purely relational framework without invoking some analogue of absolute structure. It was not until the 20th century (and the work of figures like Julian Barbour) that a genuinely relational mechanics became a live research program, and even then it requires careful formulation to avoid reinstating some form of absolute structure under another name.

Newton's recognition that the order of temporal succession is in some sense "immutable" and "absolute" — that there is a fact about which events precede which — is also preserved in relativity, where the causal order of events (whether one event is in the past, future, or lightcone-separated past of another) is observer-independent. What is lost is the global "now"; what is preserved is the reality of causal, and hence broadly temporal, structure.

What Newton Assumed and What Later Physics Overturned

The central overturned assumption is universal absolute simultaneity: the idea that all events can be assigned a unique moment in absolute time, shared by all observers. This is false. Special relativity shows that simultaneity is frame-dependent.

The related assumption — that there is a single global time-parameter that partitions the universe into instantaneous spatial slices — is also false. In general relativity, the universe's spacetime geometry is curved by matter and energy, and there is no unique "cosmic time" except in special circumstances (homogeneous, isotropic universes, like the idealized cosmological models).

The assumption that time flows at the same rate everywhere — which follows directly from Newton's claim that absolute time is "not liable to any change" regardless of the speed or acceleration of local clocks — is empirically refuted by relativistic time dilation. Clocks in motion run slow relative to stationary clocks; clocks in gravitational fields run slow relative to clocks in free space. These effects have been measured to extraordinary precision and are not merely apparent but physically real.

What Remains Philosophically Profound

Despite these revisions, several features of Newton's position retain philosophical depth.

The recognition that time has a structure that cannot be reduced entirely to observable processes — that physics requires ideal mathematical parameters, not merely recorded observations — remains methodologically important. The question of whether this structure must be grounded in something mind-independent (whether in God's eternity or in the Minkowski metric) is still actively debated.

The question of whether time would continue in an empty universe — whether duration is possible without change — is still philosophically open. Most physicists think time requires change; but some philosophers of time (following Newton's spirit, if not his physics) argue for a "substantialist" view in which spacetime exists independently of its material content.

Newton's theological intuition — that the absolute and universal character of time reflects something about the ultimate nature of reality, something that transcends the merely contingent features of the material world — has analogues in contemporary philosophical discussions of the "block universe," the objectivity of temporal order, and the status of the present moment. Whether these discussions are conducted in theological or secular terms, the underlying metaphysical questions Newton was tracking remain live.

Conclusion

Newton's theory of time is a document in four registers simultaneously: mathematical, empirical, metaphysical, and theological. In the mathematical register, it provides the ideal uniform parameter that classical mechanics requires. In the empirical register, it acknowledges that this parameter is only approximately accessible through observation and instructs the natural philosopher on how to proceed when observable measures deviate from the ideal. In the metaphysical register, it posits a real, mind-independent, motion-independent duration that is the genuine temporal order of the universe. In the theological register, it grounds this duration in the eternal endurance of an omnipresent God.

The simplification of this rich structure into the image of a "cosmic clock" — a universal ticker that all good instruments agree with — misrepresents Newton on almost every point. His absolute time is not observable, cannot be perfectly measured, does not depend on any physical process, and is grounded not in mechanics but in divinity. The simplification simultaneously over-mechanizes Newton (reducing him to a clockwork image he explicitly rejected) and under-theologizes him (stripping away the metaphysical and theological framework that held the entire structure together).

What Einstein overturned was not the crude caricature but the real doctrine: not the idea that time is what clocks measure (Newton denied this), but the idea that there is a single global temporal order for all events in the universe. This is a deep revision, and it changes the picture of physical reality fundamentally. But it does not change the underlying methodological insight that physics requires temporal structure that transcends any particular physical process, nor does it dissolve the philosophical questions about the ultimate nature of duration, the objectivity of temporal order, and the relationship between physics and metaphysics that Newton's theory so presciently, if imperfectly, raised.

Newton's time is stranger, deeper, more theological, and more philosophically vulnerable than the textbook image suggests. To understand why both it and its eventual revision matter, we must take it seriously on its own terms — which means reading Newton's actual words, with the attention they deserve and rarely receive.

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