

Newtonian Analysis of the Big Bang Model and Time-Invariant Cosmology

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ABSTRACT

This study re-examines the Big Bang model from a Newtonian and empirically oriented perspective and develops Time-Invariant Cosmology (TIC) as an alternative interpretative framework. TIC treats universal space as time-invariant and regards time, understood as the measured duration and numerical ordering of physical change, as an emergent quantity rather than an independently existing physical dimension. Within this framework, the universe is considered eternal, uncreated, and in dynamic equilibrium. Active galactic nuclei (AGNs) are interpreted as rejuvenating systems through which old matter is transformed into energetic outflows that contribute to continuing astrophysical processes. The paper further re-examines conventional interpretations of cosmological redshift and the cosmic microwave background (CMB), and questions whether observations commonly associated with cosmic expansion and an origin in a remote physical past uniquely require the standard Big Bang interpretation. The aim is not merely to criticize the standard model, but to formulate the observational and conceptual basis of TIC and to identify the physical assumptions on which the competing interpretations depend.

Keywords: cosmology; cosmic microwave background; cosmological redshift; active galactic nuclei; time-invariant cosmology.

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INTRODUCTION

The standard cosmological model (Λ CDM) provides a highly successful framework for interpreting a broad range of astronomical observations, including the large-scale distribution of matter, the redshift-distance relation of galaxies, the cosmic microwave background (CMB), and the primordial abundances of light elements (Planck Collaboration, 2020).

At the same time, fundamental questions remain concerning the physical origin of the initial conditions, the status of the initial singularity in classical extrapolations, the mechanism and onset of inflation, the nature of dark matter and dark

energy, and the interpretation of cosmic evolution. These open questions motivate continued examination of alternative cosmological frameworks. In particular, the cyclic-universe programme has been developed as an alternative to a cosmology in which the Big Bang is identified with an absolute beginning, and it has been argued that a cyclic scenario may address some problems associated with inflation and initial conditions (Turok & Steinhardt, 2005).

The possibility of a cyclic universe has a long history. Early relativistic treatments of non-static and oscillatory cosmological models were discussed by Tolman and Ward (1932) and Tolman (1934).

Modern cyclic cosmology was developed in detail by [Steinhardt and Turok \(2002a, 2002b\)](#), who proposed a sequence of cosmic epochs in which a Big Bang-like event is not necessarily interpreted as the absolute origin of the universe. Related oscillatory and bounce models have investigated whether high-energy modifications of the Friedmann equations and forms of phantom dark energy could generate repeated phases of expansion and contraction ([Baum & Frampton, 2007](#); [Brown et al., 2008](#); [Caldwell, 2002](#); [Caldwell et al., 2003](#)). These approaches show that alternatives to a unique initial beginning can be formulated within mathematically explicit cosmological models, although each framework introduces its own assumptions and unresolved physical questions.

A further cyclic construction has been studied in the context of holographic dark energy with different infrared cutoffs. [Sheykhi et al. \(2017\)](#) showed that interacting and non-interacting models can exhibit sequential phases of contraction and expansion for suitable choices of the infrared cutoff. Their holographic dark-energy density is written as

$$\rho_{DE} = k m_p^2 L^{-2} \quad (1)$$

where k is a model-dependent constant, m_p denotes the Planck mass, and L is the relevant infrared cutoff length ([Sheykhi et al., 2017](#)). Against this broader background of attempts to avoid an absolute cosmological beginning, the present paper develops a different framework: Time-Invariant Cosmology (TIC). TIC is not introduced here as another expansion-contraction cycle. Rather, it describes an eternal universe in dynamic equilibrium, without an initial Big Bang singularity and without a physically existing linear time in which the universe itself is assumed to evolve. The framework treats universal space as time-invariant and interprets measured duration as an emergent physical quantity associated with the ordering and measurement of change. This conception of time and its cosmological consequences have been developed in previous work by [Sorli et al. \(2026\)](#).

A second central element of TIC concerns the role of active galactic nuclei. Observations establish that AGNs produce powerful relativistic jets and other energetic outflows, and the composition of such jets remains an active topic of astrophysical investigation ([Nizamov & Pshirkov, 2023](#)). TIC gives these observations a specific cosmological interpretation: supermassive compact objects in galactic centers are proposed to transform old matter into energetic outflows that participate in the continuing renewal of matter and energy in the universe. Within TIC, AGNs therefore function as rejuvenating systems of an eternal universe. The underlying mechanism proposed for matter instability in compact objects has been developed in greater detail by [Fiscaletti and Sorli \(2026\)](#).

Methodologically, TIC gives priority to direct astronomical observations and to physical interpretations that can be connected as explicitly as possible with measurable phenomena. Mathematical formalisms remain essential tools, but TIC distinguishes the internal consistency of a mathematical model from the empirical question of whether the entities and processes represented by that model must be

regarded as physically real. On this basis, the paper re-examines three central elements of modern cosmology: the interpretation of an initial singularity and inflation, the interpretation of cosmological redshift, and the interpretation of the CMB as relic radiation from an early hot phase.

The central hypothesis of TIC is that the physically existing universe is an eternal, time-invariant system in dynamic equilibrium. In this interpretation, the physical past and future are not independent domains through which matter travels; rather, physical change occurs in the presently existing universe, while time functions as a measure and ordering parameter for that change. This position leads TIC to question whether observations made in the present necessarily establish an origin of the universe in a physically existing remote past. The paper therefore treats the standard cosmological interpretation and TIC as competing explanatory frameworks whose assumptions and observational consequences should be stated as explicitly as possible.

The remainder of the paper first examines conceptual problems associated with the initial singularity and inflation, with particular attention to thermodynamic and empirical questions. It then analyses cosmological redshift and develops the TIC interpretation based on gravitational effects and a dynamical quantum-vacuum framework. The subsequent discussion considers AGNs as rejuvenating systems of the universe. Finally, the Newtonian analysis is extended to the concepts of time, CMB radiation, spacetime, and the overall comparison between Big Bang cosmology and Time-Invariant Cosmology. Throughout the paper, the principal objective is to determine whether the observational evidence uniquely requires the standard expanding-universe interpretation or can be consistently reconsidered within TIC.

INITIAL SINGULARITY AND INFLATION AS CONCEPTUALLY PROBLEMATIC MODELS

The standard Big Bang cosmological scenario describes the early universe by extrapolating the relativistic cosmological equations toward states of progressively higher density and temperature. In classical general relativity, this backward extrapolation can lead to a limiting regime of geodesic incompleteness, commonly associated with an initial singularity ([Hawking & Ellis, 1973](#)).

It is important, however, to distinguish the mathematical occurrence of such a limit from the stronger physical statement that the universe was directly observed to begin as an explosion from a mathematical point. The classical singularity indicates that the theory reaches a regime in which its own applicability becomes incomplete; it does not by itself constitute an empirical observation of an absolute physical beginning.

The empirical methodology of science proceeds through observation, formulation of a physical or mathematical model, and experimental or observational testing of its consequences. In cosmology, direct experimental access to the earliest proposed epochs is not possible, and the physical conditions of those epochs are inferred from present observations through a theoretical framework.

For this reason, both the initial singularity and the inflationary phase should be regarded as theoretically reconstructed

regimes rather than directly observed events. From the perspective adopted in TIC, this distinction is fundamental because the existence of a mathematically extrapolated past boundary does not by itself establish the physical existence of an origin event.

Inflation was introduced to address important problems of the early Big Bang framework, particularly the horizon and flatness problems and the origin of primordial perturbations (Guth, 1981; Linde, 1982). Inflationary models have achieved considerable theoretical and phenomenological success, but the inflationary mechanism remains dependent on assumptions concerning the inflaton field, its potential, its initial conditions, and the transition to the subsequent hot phase. Moreover, the Borde-Guth-Vilenkin result shows that sufficiently expanding inflationary spacetimes are, under broad conditions, past-incomplete and therefore require additional physics to describe their past boundary (Borde et al., 2003).

Thus, inflation does not remove every conceptual question concerning cosmic origin. From the TIC standpoint, the problem is therefore not that standard cosmology lacks mathematical structure, but that its description of an initial physical origin depends on extrapolation beyond observationally accessible conditions.

TIC questions whether such an extrapolation is necessary and proposes instead that the universe can be treated as eternal and time-invariant, thereby eliminating the requirement for an absolute creation event. This does not deny the usefulness of early-universe calculations; rather, it challenges the interpretation that these calculations uniquely establish a physically existing beginning of the universe.

The relation between cosmology and the first law of thermodynamics also requires careful formulation. In general relativity, local energy-momentum conservation is expressed covariantly by $\nabla_\mu T_{\mu\nu} = 0$. However, in a general expanding spacetime there is no unique global conserved energy defined in the same way as in Newtonian mechanics or in a stationary spacetime (Wald, 1984).

For this reason, it would be imprecise simply to state that the standard Big Bang model or inflation violates the first law of thermodynamics. The more specific concern raised here is that the global origin and accounting of the total physical content of the universe are not described by an experimentally established conservation law of the ordinary laboratory type. Attempts to address this issue sometimes invoke the possibility that the total energy of the universe is zero, with positive matter-energy balanced by negative gravitational energy (Hawking & Mlodinow, 2010).

Such a description is conceptually suggestive, but gravitational energy in general relativity does not possess a unique local density or a universally defined global value for arbitrary cosmological spacetimes. Consequently, the zero-total-energy idea should be treated as a model-dependent interpretation rather than as an experimentally demonstrated physical mechanism for the origin of matter and gravitational energy. Quantum-cosmological proposals have also sought to reformulate the classical beginning. The Hartle-Hawking no-boundary proposal, for example, replaces the classical initial boundary with a quantum description of the universe (Hartle & Hawking, 1983).

The existence of such proposals illustrates that the classical singularity is not generally regarded as a complete physical account of the origin. TIC adopts a different solution: instead of replacing the singularity with another boundary condition, it removes the need for a physical beginning altogether and treats the universe as an eternal system in dynamic equilibrium.

Accordingly, the present analysis retains the original TIC objection in a more precise form. The initial singularity and inflation are mathematically motivated components of standard cosmological modeling, but their interpretation as a physically established origin of the universe is not directly verified by observation. The TIC alternative therefore asks whether the available astronomical evidence can be explained without assuming an absolute beginning and without introducing a physically existing temporal domain in which the universe itself is created and evolves. This question provides the basis for the subsequent analysis of cosmological redshift, gravitational effects, and the interpretation of the CMB.

COSMOLOGICAL REDSHIFT AS A MODEL-DEPENDENT INTERPRETATION

Redshift is an observed property of electromagnetic radiation and can arise through more than one physical mechanism. Doppler redshift is experimentally established for relative motion between source and observer, while gravitational redshift is a direct consequence of gravitational potential differences and has been verified experimentally (Einstein, 1911; Pound & Rebka, 1959).

In standard cosmology, an additional interpretation is used: for sufficiently large cosmological distances, the observed redshift is related to the evolution of the FLRW scale factor. This interpretation is theoretically well defined within general relativity, although it does not have a direct laboratory analogue in which metric expansion of cosmological space itself is reproduced.

The central TIC objection is therefore not that cosmological redshift lacks a mathematical description, but that the observed wavelength shift does not by itself uniquely establish the physical expansion of space. The inference from measured redshift to metric expansion depends on the adopted cosmological framework. TIC instead investigates whether a substantial part of the observed redshift can be interpreted through gravitational energy exchange associated with the large-scale gravitational environment of galaxies and intergalactic space.

This alternative interpretation must ultimately be judged quantitatively by its ability to reproduce the observed redshift-distance relation and other cosmological tests. Within standard cosmology, the Hubble relation connects recession rate and distance on sufficiently large, unbound scales. A simple extrapolation of the Hubble rate to a laboratory baseline on Earth is not, however, a decisive test of cosmic expansion, because gravitationally and electromagnetically bound systems are not normally expected to participate in the Hubble flow in the same manner as the large-scale cosmic distribution. Consequently, the absence of measurable Hubble expansion

across a terrestrial distance cannot by itself discriminate between TIC and FLRW cosmology.

A meaningful empirical comparison must instead focus on observables for which the competing models make different quantitative predictions on astrophysical or cosmological scales.

The motion of galaxies and galaxy groups is also affected by peculiar gravitational velocities in addition to any cosmological component. Large-scale flow studies, including investigations of the Laniakea region and the Great Attractor, illustrate the importance of gravitationally induced motions. TIC assigns greater interpretative weight to such gravitational dynamics and therefore seeks to determine how far gravitational effects can account for redshift observations without invoking metric expansion as the primary mechanism.

GRAVITATIONAL FIELD AND GRAVITATIONAL REDSHIFT

In the TIC framework, gravity is associated with spatial variations in the energy density of a fundamental dynamical quantum vacuum. The model assumes that the vacuum-energy density reaches a maximum value ρ_{PE} in intergalactic space and is reduced in the interior of a gravitating body. The mass-energy of a stellar object is then represented through the difference between the external and central vacuum-energy densities according to

$$\rho_{PE} = \rho_{CE} + \frac{mc^2}{V}$$

$$E = mc^2 = (\rho_{PE} - \rho_{CE})V \quad (2)$$

where m is the mass of the stellar object, V is its volume, ρ_{PE} is the reference vacuum-energy density, and ρ_{CE} is the corresponding energy density at the centre of the object (Sorli et al., 2023). Within the same model, the gravitational mass is written as

$$m \approx m_g = \frac{V}{c^2}(\rho_{PE} - \rho_{CE}) \quad (3)$$

and the Newtonian gravitational force between two bodies is retained in the form

$$F_g = G \frac{m_{g1} m_{g2}}{r^2} \quad (4)$$

where G is the gravitational constant and r is the distance between the bodies. Equations (2) – (4) express the specific TIC hypothesis that gravitational mass is linked to a difference in vacuum-energy density; this hypothesis is not part of standard general relativity and must therefore be regarded as a model assumption to be tested against observation.

The gravitational-redshift relation in the original manuscript requires correction. Redshift z is dimensionless, whereas the expression $2Gm/(r^2c^2)$ has dimensions of inverse length and therefore cannot represent z . For radiation emitted at radius r from a static spherical mass m and received at infinity, the Schwarzschild result is

$$1 + z = \left(1 - \frac{2Gm}{rc^2}\right)^{-1/2} \quad (5a)$$

and in the weak-field limit, where $Gm/(rc^2) \ll 1$, this reduces to

$$z \approx \frac{Gm}{rc^2} \quad (5b)$$

This form is dimensionally consistent and reproduces the experimentally verified weak-field gravitational redshift. Substituting Eq. (3) into Eq. (5b) gives

$$z \approx \frac{G}{rc^4} V(\rho_{PE} - \rho_{CE})$$

For a spherical body of radius r , $V = 4/3\pi r^3$, and therefore

$$z \approx \left(\frac{4\pi G}{3c^4}\right) r^2(\rho_{PE} - \rho_{CE}) \quad (6)$$

Equation (6) is the dimensionally consistent weak-field form of the TIC substitution. It preserves the intended connection between gravitational redshift, object size, and the assumed vacuum-energy-density difference while avoiding the dimensional inconsistency in the original Eq. (5). For two objects of equal mass, the more compact object has the larger value of $G(m/rc^2)$ and therefore the larger gravitational redshift.

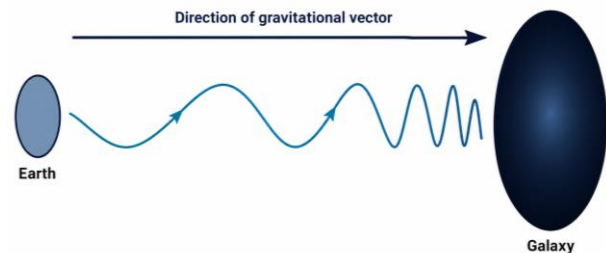


Figure 1. Gravitational redshift (retained from the original manuscript).

In gravitational blueshift, radiation gains energy when received deeper in a gravitational potential; in gravitational redshift, the received photon energy is lower when radiation propagates toward a region of higher gravitational potential. In the weak-field interpretation, this energy difference can be described consistently through the gravitational potential difference between emitter and receiver.

Standard cosmology describes cosmological redshift through the evolution of the FLRW scale factor, commonly written as $1 + z = a(t_0)/a(t_e)$, where $a(t_e)$ is the scale factor at emission and $a(t_0)$ is its value at observation. This relation is mathematically explicit, but TIC questions whether the scale-factor interpretation is the only physically admissible explanation of the observed wavelength shift. The frequently used stretching-rubber-band analogy is pedagogical rather than a microscopic mechanism, and it should not be treated as an experimental demonstration of expanding space itself (NASA, 2024).

The evidential situation should therefore be stated carefully. Doppler and gravitational redshifts have direct experimental realizations, whereas cosmological redshift is inferred from astronomical observations within a relativistic cosmological model. This difference does not by itself falsify FLRW cosmology, but it motivates the TIC programme of seeking an alternative account in which gravitational effects play the dominant role. Any such account must reproduce not only the existence of redshift but also its systematic dependence on distance and the wider set of cosmological observables.

The logical comparison proposed by TIC can thus be reformulated more rigorously. Standard cosmology proceeds from a relativistic model in which the scale factor evolves and predicts a cosmological redshift-distance relation. TIC begins from the experimentally established existence of gravitational redshift and asks whether an alternative large-scale gravitational model can reproduce the same observations without metric expansion. The two approaches should therefore be compared through quantitative predictions rather than by treating either interpretative premise as a direct observation. This formulation preserves the central TIC aim while placing the disagreement at the level of testable physical models.

DARK ENERGY AND THE INTERPRETATION OF ANTIGRAVITATIONAL BEHAVIOR

Within standard cosmology, the term dark energy denotes the component responsible for the observed late-time accelerated expansion. The simplest realization is a cosmological constant Λ , which enters Einstein's field equations as a geometrical term and is dynamically equivalent to a fluid with negative pressure (Peebles & Ratra, 2003; Weinberg, 1989).

Einstein originally introduced Λ in 1917 in an attempt to construct a static relativistic cosmological model and later abandoned that specific use after expanding-universe models became dominant (Einstein, 1917; Nussbaumer, 2014).

The contemporary use of Λ is therefore physically and historically distinct from Einstein's original static-universe motivation.

It is important to state the standard interpretation accurately. General relativity does not require dark energy to act as a conventional repulsive force between two local bodies. Instead, a sufficiently negative pressure term can produce accelerated evolution of the cosmological scale factor. At the same time, the microscopic physical nature of dark energy remains unresolved, and the very small observed vacuum-energy density compared with naive quantum-field estimates is the well-known cosmological-constant problem (Weinberg, 1989).

Thus, the empirical evidence for accelerated cosmic expansion and the deeper question of what dark energy physically is should be kept conceptually distinct. Time-Invariant Cosmology (TIC) adopts a different interpretation. In TIC, the vacuum is treated as a dynamical physical background whose energy density can vary spatially, and gravitational phenomena are attributed to these variations rather than to an intrinsic antigravitational property of dark energy. Accordingly, the TIC objection is not that the Λ term lacks a mathematically defined effect in general relativity; rather, it is

that the physical ontology assigned to dark energy is not uniquely fixed by the observational data. The model therefore seeks to explain gravity and large-scale observations without interpreting the vacuum as a substance that locally repels matter.

This distinction also clarifies how critical literature should be used. Traummüller (2018), for example, questioned whether the standard dark-energy interpretation is uniquely demanded by supernova magnitude-redshift data. Such critiques do not by themselves establish TIC, but they support the broader methodological point that alternative interpretations of cosmological observations can be examined. Within TIC, the proposed alternative is a dynamical-vacuum framework in which spatial differences in vacuum-energy density participate in gravitational phenomena.

FLRW EXPANSION AND EUCLIDEAN SPATIAL GEOMETRY

Observations constrain the spatial curvature of the observable universe to be very close to zero. In a modern analysis combining Planck data with other geometrical measurements, Efstathiou and Gratton (2020) obtained $\Omega_K = 0.0004 \pm 0.0018$, consistent with spatial flatness. Spatial flatness, however, should not be identified with a static universe. In the Friedmann-Lemaître-Robertson-Walker (FLRW) framework, a spatially flat universe ($k = 0$) can still possess a time-dependent scale factor $a(t)$. This distinction is important because a mathematical objection based solely on the Euclidean distance formula would not, by itself, invalidate the flat FLRW solution. For reference, the ordinary Euclidean distance between two points p and q in n dimensions is

$$d(p, q) = \sqrt{\sum_{i=1}^n (p_i - q_i)^2} \quad (7)$$

Equation (7) defines distances within a fixed Euclidean metric. By contrast, the FLRW model introduces cosmic evolution through a scale factor. On sufficiently large scales, the corresponding observational relation is commonly summarized by the Hubble law

$$v = H_0 D \quad (8)$$

where v is the recession rate assigned within the cosmological model, H_0 is the present Hubble parameter, and D is an appropriate cosmological distance. The measured quantity is typically a redshift together with independently calibrated distance information; the recession interpretation is therefore embedded in a relativistic cosmological model rather than obtained as a direct local velocity measurement. This model dependence is precisely the point on which TIC focuses.

A convenient isotropic form of a constant-curvature spatial metric can be written as

$$d\sigma^2 = \frac{dx^2 + dy^2 + dz^2}{\left(1 + \frac{k}{4}(x^2 + y^2 + z^2)\right)^2} \quad (9)$$

For $k = 0$, Eq. (9) reduces to a Euclidean spatial metric. In FLRW cosmology, however, the physical spatial line element contains the additional factor $a^2(t)$.

Consequently, standard general relativity is mathematically compatible with flat spatial sections and a changing scale factor. The stronger and more defensible TIC question is therefore not whether FLRW mathematics permits $k = 0$ expansion, but whether the scale factor should be interpreted as a physically expanding substance called space or as an effective geometrical description of large-scale observations. This reformulation preserves the central TIC objective while avoiding a geometrical paradox. TIC interprets the measured redshift primarily through gravitational interaction and rejects the necessity of physical expansion of universal space. Standard cosmology instead relates cosmological redshift to the ratio of scale factors between emission and observation. Tremblin and Chabrier (2024) have emphasized that the redshift-distance relation is derived within the FLRW framework, illustrating explicitly that the observational meaning of redshift depends on the adopted cosmological description.

Alternative redshift formulations have also been discussed. Vavryčuk (2022), for example, explored relations between gravitational and cosmological redshift within an FLRW setting. Such work does not demonstrate that the two mechanisms are observationally identical in all circumstances, but it reinforces the need to distinguish the measured dimensionless redshift from the physical mechanism assigned to it. TIC therefore treats the expansion interpretation as a hypothesis to be tested against competing explanations rather than as a direct observation of space itself expanding.

AGNS AS REJUVENATING SYSTEMS OF THE UNIVERSE

The role assigned to active galactic nuclei (AGNs) is one of the most distinctive elements of TIC. Standard astrophysics explains AGN luminosity and relativistic jets primarily through accretion onto supermassive compact objects, magnetohydrodynamic processes, and extraction of rotational energy; the Blandford-Znajek mechanism is a classical example of such an energy-extraction model (Blandford & Znajek, 1977; Davis & Tchekhovskoy, 2020).

TIC does not deny the observational reality of accretion disks and jets, but proposes an additional physical interpretation: the central compact region participates in a conversion process through which old matter is destabilized and contributes to energetic outflows. In this sense, AGNs are proposed to function as rejuvenating systems within an eternal universe. The singularity issue must also be stated precisely. Penrose's singularity theorem does not assert that an experimentally observed point of infinite mass density exists at the center of every black hole; it establishes geodesic incompleteness under specified conditions in general relativity (Penrose, 1965).

The classical Schwarzschild solution nevertheless contains a curvature singularity at $r = 0$, and the physical resolution of such singular behavior remains an open problem. Recent discussions of non-singular black-hole paradigms similarly treat classical singularities as signals that a more complete description may be required (Carballo-Rubio et al., 2025; Lehmkuhl, 2025).

TIC adopts this non-singular motivation but proposes its own microscopic mechanism.

In the TIC model, the energy density of the dynamical quantum vacuum decreases toward the interior of sufficiently compact objects. Using the mass-energy relation already introduced in Eq. (3), the Schwarzschild-radius expression is rewritten as

$$r_s = \frac{2GM}{c^2} = 2G \left(\frac{V}{c^4} \right) (\rho_{PE} - \rho_{CE}) \quad (10)$$

Equation (10) is algebraically consistent with the TIC identification $M = (V/c^2)(\rho_{PE} - \rho_{CE})$.

Its physical interpretation, however, is model-specific: TIC assumes that a sufficiently reduced vacuum-energy density changes the electromagnetic stability of matter before a classical point singularity is physically realized. The resulting conversion of bound matter into elementary-particle and radiation components is proposed as a source of pressure and energy available to compact-object outflows (Fiscaletti & Sorli, 2026).

The original formulation associated this mechanism with explosive compact-object phenomena and with the axial outflows of supermassive black holes. To retain the scientific aim without conflating established stellar-supernova mechanisms with the TIC hypothesis, the present paper treats this as a specific model proposal: in sufficiently compact configurations, matter instability may generate energetic products, while in rotating supermassive systems the preferred escape channel may be aligned with the rotation axis. Figure 2 illustrates this proposed TIC mechanism.

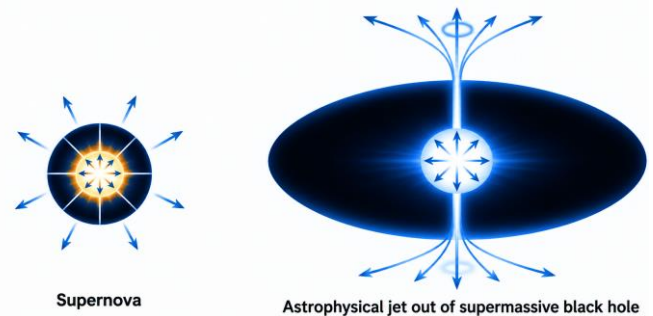


Figure 2. Schematic TIC interpretation of explosive compact-object outflow and an astrophysical jet from a supermassive black hole (adapted from the original manuscript).

The proposed microscopic mechanism is developed by allowing the reduced Planck constant in the compact-object interior to depend on the local vacuum-energy density. For the numerical example used in the original model, the reduced Planck constant at the black hole-center with $2.9 \odot$ is written as

$$\hbar_{bh} = \frac{1}{c} (\rho_{PE} - 1.62 \times 10^{26} J m^{-3}) l_p^4 \quad (11)$$

where l_p is the Planck length. Equation (11) should be understood as a defining hypothesis of the TIC compact-object model, not as a relation established by standard quantum field theory. If e , α , and c are treated as fixed, the electromagnetic

identity relating the fine-structure constant to vacuum permittivity gives

$$\varepsilon_{0,bh} = \frac{1}{\mu_{0,bh} c^2} = \frac{e^2}{4\pi\alpha\hbar_{bh} c} \quad (12)$$

so that a decrease in $\hbar_{bh}$ corresponds, within these assumptions, to an increase in $\varepsilon_{0,bh}$. The electrostatic force between two charges is then written as

$$F_{bh} = \left(\frac{1}{4\pi\varepsilon_{0,bh}} \right) \left(\frac{q_1 q_2}{r^2} \right) \quad (13)$$

and the model summarizes the proposed chain of changes as

$$\varepsilon_0 \mu_0 c^2 = 1 \quad , \quad \mu_{0,bh} = \frac{1}{\varepsilon_{0,bh} c^2}$$

$$\begin{aligned} (\rho_{PE} > \rho_{cE}) &\rightarrow (\hbar > \hbar_{bh}) \rightarrow (\varepsilon_{0,bh} > \varepsilon_0) \\ &\rightarrow (\mu_{0,bh} < \mu_0) \rightarrow (F > F_{bh}) \end{aligned} \quad (14)$$

Equations (11) – (14) therefore constitute a linked TIC hypothesis: a change in vacuum-energy density produces a change in the effective quantum and electromagnetic parameters and, consequently, a reduction in electrostatic binding. This is a strong assumption and should be judged by its quantitative predictions.

In particular, a viable version of the model must remain consistent with precision constraints on fundamental constants outside the extreme compact-object environment and should specify observables by which the proposed interior variation could be distinguished from standard plasma and magnetohydrodynamic processes.

The original model further considers the stability of matter in neutron-star and black-hole interiors. If an electron is represented by the toroidal-photon model discussed by [Williamson and van der Mark \(1997\)](#), its characteristic energy in the altered interior environment is written as

$$E_{photon} = 2\pi\hbar_{bh}\nu \quad (15)$$

The TIC interpretation is that a reduced $\hbar_{bh}$ lowers the corresponding energy scale and may modify binding conditions. Because the toroidal-photon description of the electron is not part of the standard model of particle physics, Eq. (15) is retained here explicitly as a model-dependent assumption whose physical consequences require independent testing. In intergalactic space, the model defines the reduced Planck constant by

$$\hbar = \rho_{PE} \left(\frac{l_P^4}{c} \right) \quad (16)$$

and, for the center of a compact object of mass M and volume V , by

$$\hbar_{BH} = \left(\frac{l_P^4}{c} \right) \left(\rho_{PE} - \frac{Mc^2}{V} \right) \quad (17)$$

Equations (16) and (17) are dimensionally consistent because an energy density multiplied by l_P^4/c has the dimensions of action.

Their empirical content, however, depends on the TIC postulate that the local value of $\hbar$ changes with vacuum-energy density ([Fiscaletti & Sorli, 2026](#)).

This postulate is therefore a natural target for falsification: the model should ultimately predict quantitative compact-object signatures that cannot be reproduced by conventional accretion, plasma, or jet physics.

Within this framework, AGNs are interpreted as sites of local conversion of old matter into energetic particles and radiation, which are then carried into intergalactic space through jets and winds. The observable existence, large energy fluxes, and particle content of AGN jets are well established; what is specific to TIC is the proposed origin of part of that energy and matter in vacuum-density-induced instability inside the central compact object. This distinction makes the hypothesis scientifically clearer: the observations establish the jets, whereas the rejuvenation mechanism is the TIC explanation to be evaluated against standard accretion and black-hole jet models.

NEWTONIAN ANALYSIS OF THE BIG BANG COSMOLOGY AND TIME-INVARIANT COSMOLOGY

The present section develops the central comparison between standard Big Bang cosmology and Time-Invariant Cosmology (TIC) from the empirical and Newtonian perspective adopted in this paper. The purpose is not to deny the observational achievements of modern cosmology, many of which are quantitatively successful, but to examine whether those observations uniquely require an expanding universe with a physically real temporal origin. TIC maintains that the observations can be interpreted within an eternal, time-invariant universe in dynamic equilibrium, and therefore treats the origin of the universe, an initial singularity, and a physically existing remote past as model-dependent rather than directly observed conclusions.

A useful distinction is required here between falsifiable predictions of the standard cosmological model and claims concerning an absolute beginning. Parameters and predictions of Λ CDM can be tested against supernovae, the CMB, baryon acoustic oscillations, large-scale structure, and other observations.

TIC does not dispute that these tests exist. Its criticism concerns the additional interpretation that the same observations establish a physically real beginning of the universe. Within TIC, the latter inference is regarded as conceptually underdetermined by observation. The working principles of TIC used in the present analysis can be summarized as follows:

- Time is treated as the measured duration and numerical ordering of physical change in a time-invariant space.
- Astrophysical jets from active galactic nuclei are interpreted as part of a continuing rejuvenation process that supplies energetic matter and radiation to the cosmic environment.

- The cosmic microwave background (CMB) is interpreted within TIC as radiation associated with the present physical substrate of universal space rather than as relic radiation that requires a physically existing temporal past.
- Large cosmological redshifts are investigated within TIC primarily in relation to gravitational and vacuum-energy effects rather than being assumed a priori to demonstrate metric expansion.

These statements are hypotheses of the TIC framework and therefore require observational and quantitative testing. This formulation is stronger scientifically than treating them as conclusions that follow automatically from the rejection of the standard model. It also makes clear what must ultimately distinguish TIC from Λ CDM: the two frameworks must lead to different, testable predictions for cosmological observables.

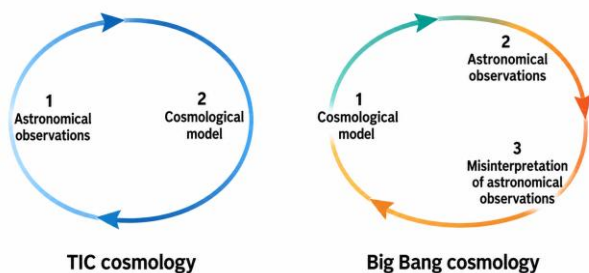


Figure 3. Schematic comparison of the research pathways proposed in TIC and standard Big Bang cosmology.

Figure 3 summarizes the methodological contrast intended by the authors. In the TIC pathway, astronomical observations are related as directly as possible to the proposed cosmological model. In the standard pathway, observations are interpreted through a relativistic cosmological framework before they are assigned a physical meaning. The figure should not be read as implying that standard cosmology is non-empirical; rather, it represents the TIC claim that some cosmological conclusions depend more strongly on theoretical interpretation than the underlying observations themselves.

Spatial flatness is an important example. CMB observations are consistent with a universe whose large-scale spatial curvature is very close to zero (NASA, 2014; Planck Collaboration, 2020).

TIC interprets this result as supporting the use of an effectively Euclidean spatial description. However, spatial flatness alone does not mathematically imply a static universe, because a flat FLRW model can have zero spatial curvature while retaining a time-dependent scale factor.

The TIC objection must therefore be formulated physically rather than as a purely geometric prohibition: the question is whether the observed redshift-distance relation requires the scale factor to represent a real expansion of universal space, or whether a stationary interpretation can reproduce the same observations with fewer ontological assumptions.

The same caution applies to the inference of spatial infinity. A measured curvature consistent with zero does not, by itself,

establish that the total universe is infinite; global topology remains observationally underdetermined.

TIC nevertheless adopts an infinite Euclidean universe as a model assumption consistent with the Newtonian picture discussed in this paper. Within such a framework, Olbers' paradox cannot be solved by infinity alone.

A stationary cosmology must additionally provide a quantitative account of why the integrated radiation from arbitrarily distant sources does not produce a bright night sky. This becomes an explicit physical requirement for TIC rather than an automatic consequence of an infinite universe. Historical alternatives to an expanding universe are relevant in this context.

Assis and Neves (1995) reviewed pre-Big-Bang estimates of the microwave-background temperature and argued that the 2.7 K background did not uniquely select an expanding Big Bang cosmology. Their analysis is useful here as an example of underdetermination: the same observation can acquire different meanings within different theoretical frameworks. TIC adopts a related methodological position but develops it through its own assumptions concerning time-invariant space, gravitational redshift, and the energetic role of AGNs.

THE CMB IN STANDARD COSMOLOGY AND TIC

The CMB is one of the most important discriminants between cosmological models. In standard cosmology, photons decoupled from matter when the universe became sufficiently neutral, at a redshift of approximately 1100 and a temperature of order 3000 K. The subsequent expansion of the universe redshifts the photon wavelengths while preserving an almost perfect black-body spectrum; the effective radiation temperature scales approximately as $T \propto 1/a$. The present CMB temperature is about 2.725 K, and its spectrum is extraordinarily close to that of a black body (Fixsen, 2009; Planck Collaboration, 2020).

TIC proposes a different physical interpretation. It regards the observed CMB as radiation associated with the present energetic substrate of universal space rather than as radiation whose physical origin must be located in a remote temporal epoch.

This proposal preserves the main aim of TIC, but it also defines a demanding empirical task: a viable stationary model must account quantitatively for the CMB spectrum, its temperature, its near-isotropy, its anisotropy power spectrum, and its polarization properties. Wien's displacement law relates the temperature of a black body to the wavelength at which its spectral radiance is maximal:

$$\lambda_{\max} = \frac{b}{T}, \quad b \approx 2.8978 \times 10^{-3} \text{ m} \cdot \text{K} \quad (18)$$

For $T \approx 3000$ K, this relation gives $\lambda_{\max} \approx 966$ nm, whereas for $T \approx 2.7$ K it gives a peak wavelength of order 1.07 mm. Equation (18), however, should not be used by itself to decide between the two cosmologies.

Wien's law characterizes the spectrum of thermal radiation; it does not specify the dynamical mechanism by which an already emitted photon changes wavelength. In standard cosmology that mechanism is metric redshift, whereas TIC

challenges the physical necessity of that interpretation and seeks an alternative present-space origin for the observed spectrum.

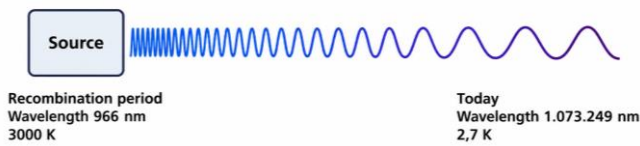


Figure 4. Schematic representation of the standard red-shifting interpretation of radiation from the recombination epoch to the present CMB.

Figure 4 should therefore be interpreted as a schematic of the standard explanation, not as a derivation from Wien's law. For TIC to replace that explanation, it is not sufficient merely to state that the original emitting source no longer exists. The alternative model must specify a present physical source or field capable of generating the observed black-body spectrum and must show how the measured CMB anisotropies and polarization arise within that framework.

Recent observations of apparently massive galaxies at high redshift have also motivated discussion of the timescales available for early structure formation.

Labbé et al. (2023) reported a population of red, massive-galaxy candidates at very early cosmic epochs, and Gupta (2023) explored an alternative cosmological construction that combines varying couplings with a tired-light component and yields a substantially larger inferred cosmic age. Such studies are relevant to the present discussion because they demonstrate that inferred ages and formation histories depend on the adopted cosmological model.

They should not, however, be treated by themselves as proof that Λ CDM has failed or that the universe is 27 billion years old. Within TIC, they are better regarded as motivation for testing whether a time-invariant framework can reproduce high-redshift observations quantitatively.

TIME AS AN EMERGENT QUANTITY AND THE TIC INTERPRETATION OF CMB PROPAGATION

A foundational assumption of TIC is that time is not an independently existing physical substance or dimension through which matter and radiation move. Instead, time is treated as an emergent quantity used to order changes and measure their duration in a time-invariant space (Sorli et al., 2026).

This is an ontological interpretation rather than a direct experimental result, and it should be presented as such. The empirical content of the proposal lies in whether physical predictions can be formulated without assigning independent physical existence to a temporal dimension.

From this viewpoint, an electromagnetic signal propagates through space, while its travel time is the measured duration of that propagation. TIC therefore rejects the literal picture that radiation moves 'through the past' or that the past exists as a physical region. Standard cosmology, by contrast, uses lookback time as a relational measure connecting the emission

event and the observation event within a space-time model. The disagreement is consequently not about whether light requires a finite propagation interval, but about the ontology assigned to time and to the historical reconstruction of the universe.

In the TIC interpretation, this distinction is applied directly to the CMB. If time is only an ordering and duration parameter, then the statement that CMB photons 'exist in the past' is rejected. Instead, the radiation detected now is a presently existing physical field whose origin must be accounted for in the presently existing universe. TIC proposes that the energetic substrate of space provides that source. This is a clear alternative hypothesis, but it requires an explicit emission or equilibrium mechanism and quantitative predictions that can be compared with the measured CMB.

The broader TIC picture is that spatial and material changes occur within one physically existing, time-invariant arena. Successive states can be ordered and their durations measured without postulating that past and future are independently existing physical domains. Figure 5 illustrates this contrast schematically.

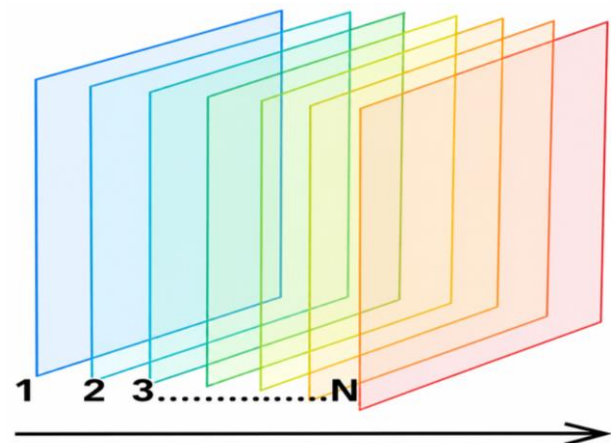


Figure 5. Schematic representation of successive ordered states ('Now') in the discussion of time-invariant space.

In conventional space-time language, the sequence of states is represented along a temporal coordinate. TIC interprets the same sequence as ordered transformations occurring in the same time-invariant space. The figure is therefore not an experimental demonstration of TIC; it is a conceptual representation of the ontology adopted by the model. This distinction is important because it separates what is directly observed the succession of physical changes and clock readings from the interpretation of time as an independently existing physical dimension.

The cosmological principle is correspondingly extended in TIC from large-scale spatial homogeneity and isotropy to a stronger time-invariant hypothesis: the fundamental functioning of the universe is assumed not to depend on a privileged cosmic epoch. This stronger condition is not implied by the conventional cosmological principle and must be treated as a specific TIC postulate.

Its scientific value will depend on whether it yields distinctive predictions for populations of galaxies, AGNs, background

radiation, elemental abundances, and other observables as a function of redshift. Within this framework, CMB and cosmological redshift are interpreted as two observational phenomena whose conventional historical explanations are reconsidered from the standpoint of the present physical state of universal space. Standard cosmology explains them through relic radiation and metric expansion, respectively. TIC instead seeks a unified description in terms of the energetic and gravitational properties of a time-invariant space.

The main scientific task for the subsequent development of TIC is therefore not merely to reject the standard historical interpretation, but to derive quantitative, falsifiable consequences that distinguish this alternative description from Λ CDM while preserving its central premise of an eternal, uncreated universe.

TIME FROM ENTANGLEMENT AND TIME-INVARIANT COSMOLOGY

The Page–Wootters mechanism provides an important example of how an effective notion of time can emerge relationally within a quantum system. In this approach, a subsystem used as a clock is correlated with the remaining degrees of freedom, so that evolution can be described through correlations even when the global quantum state is subject to a stationary constraint (Page & Wootters, 1983).

Later studies have clarified and extended this relational construction, showing how effective temporal evolution can arise from quantum correlations under appropriate conditions (Favalli & Smerzi, 2022; Favalli, 2024; Foti et al., 2021).

TIC adopts this work as motivation for an ontological interpretation in which time is not an independently existing physical substance. This is an extension beyond what the Page–Wootters mechanism itself establishes. Within TIC, time is defined as the numerical ordering and measured duration of physical changes occurring in time-invariant space (Fiscaletti & Sorli, 2015).

The framework therefore distinguishes between measurable clock readings, which are physical records produced by material systems, and an additional hypothesis that a separate temporal entity must exist in which those systems move.

The authors further propose that time-invariant space provides the common physical arena in which correlations between systems occur. This statement should not be understood as claiming that every macroscopic object is quantum-entangled with every other object in the operational sense used in quantum-information experiments.

Rather, TIC uses the relational character of quantum time as conceptual support for the broader hypothesis that physical change does not require an independently existing temporal dimension. On this basis, hypothetical travel into a physically existing past or future is excluded within TIC; an observer can change spatial position and undergo successive physical states, while time denotes the measured ordering and duration of those changes (Gorjup et al., 2024).

Accordingly, TIC interprets the Page–Wootters result as evidence that a description of physical evolution can be constructed without introducing an external universal time parameter. It does not follow from the Page–Wootters

formalism alone that spacetime is physically unreal or that all conventional uses of time in relativity must be abandoned.

The stronger conclusion that universal space is time-invariant is a specific postulate of TIC. Its scientific status therefore depends on whether the resulting cosmological framework can reproduce observations and generate testable consequences that distinguish it from standard relativistic cosmology.

This formulation preserves the central TIC claim while placing it on a more precise basis: measured duration is real as an operational quantity, but TIC denies that duration must correspond to an independently existing physical dimension. The universe, in this interpretation, exists and changes in the presently existing physical arena, while past and future are descriptions of ordered states rather than separately existing regions of reality.

TIME PERCEPTION, TIME EXPERIENCE, AND COSMOLOGICAL CONSEQUENCES

Human experience of temporal order is closely related to neural mechanisms that encode duration, sequence, and interval timing. Neuroscience has identified distributed neural systems involved in the estimation and organization of temporal intervals (Buhusi & Meck, 2005).

These findings demonstrate that temporal perception has a biological component, although they do not by themselves establish that physical time is nonexistent. TIC therefore uses the neuroscience of timing as supporting motivation for distinguishing subjective temporal experience from the physical ordering of material changes.

In the TIC interpretation, the observer directly detects physical configurations and motions through sensory and instrumental interactions, while the brain organizes sequences of such changes into an experienced temporal order. This provides a conceptual basis for distinguishing the physical succession of states from the psychological experience of past, present, and future. The authors have previously described this distinction in terms of temporal and timeless modes of cognition (Sorli & Celan, 2022).

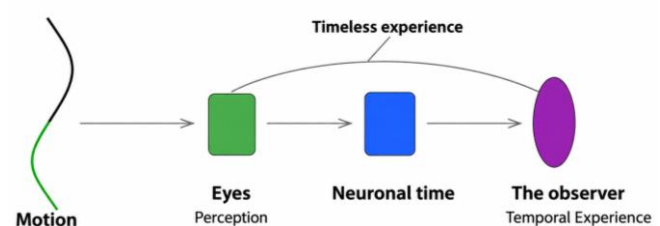


Figure 6. Schematic comparison of temporal and time-invariant interpretations of observed motion.

Figure 6 is a conceptual illustration rather than experimental evidence. It represents two interpretations of the same observational process: in the conventional description, motion is represented together with a temporal coordinate, whereas TIC describes the observer as perceiving successive physical configurations in time-invariant space and assigning duration to their change. The scientific question is therefore not whether observers measure time they clearly do but whether the

measured quantity requires time to exist as an independent physical entity.

The cosmological consequence of this position is substantial. TIC denies that the physical past and future exist as separate domains through which matter or radiation can travel. When an astronomer observes light emitted by a distant object, the received signal carries information about the state of that object at emission after a finite propagation interval. Standard cosmology expresses this relation through lookback time in spacetime. TIC accepts the propagation interval and the historical information carried by the signal but interprets both the emission and observation as physical events occurring in the same time-invariant spatial reality, ordered by change rather than embedded in an independently existing temporal substance.

This distinction should also moderate claims concerning observational access to the past. Astronomers do not physically travel to an earlier state of the universe when they observe a distant galaxy; they receive photons that were emitted earlier according to measured propagation intervals. Standard relativistic language describes this as looking back in time, whereas TIC treats it as receiving presently existing signals containing information about preceding physical states. The difference is ontological rather than observational. TIC extends the cosmological principle beyond large-scale spatial homogeneity and isotropy by postulating time-invariant physical functioning: the fundamental laws and large-scale regenerative mechanisms of the universe are assumed not to depend on a privileged cosmic epoch.

This is stronger than the conventional cosmological principle and must therefore be tested rather than assumed. Observable evolution in galaxy populations, metallicity, background radiation, and AGN activity provides potential empirical constraints on this stronger TIC hypothesis.

RE-EXAMINING THE SPACETIME REPRESENTATION IN TIC

The spacetime formulation of special relativity combines spatial and temporal coordinates into a four-dimensional geometrical structure. In an older but mathematically equivalent notation, Einstein represented the fourth coordinate using an imaginary quantity proportional to ct , so that the interval could be written in a formally Euclidean-like four-coordinate form (Einstein, 1920). The relevant coordinate definition is

$$x^4 = \sqrt{-1} ct \quad (19)$$

Equation (19) is a coordinate convention; it is not the algebraic statement $t = ict$. The factor c converts the time coordinate into units of length, and the factor i was historically used to encode the Lorentzian signature in a Euclidean-looking notation. Modern treatments generally use a real time coordinate and an explicit Lorentzian metric signature. Consequently, the historical use of ict is not, by itself, a mathematical inconsistency in special relativity.

The TIC objection is instead ontological. The fact that ct has dimensions of length permits time-related measurements to be represented geometrically, but TIC argues that successful

geometrization does not prove that time exists as a material or independently observable physical dimension.

In this framework, spacetime is regarded as a highly effective mathematical representation of relations among events, while the underlying physical ontology is proposed to consist of time-invariant space, material systems, fields, and their changes.

The conventional $(3 + 1)$ -dimensional description should therefore be distinguished from the TIC interpretation of what the fourth coordinate represents. Contemporary physics treats spacetime as a four-dimensional pseudo-Riemannian geometry, with one timelike and three spacelike directions; this does not mean that the temporal coordinate is mathematically identical to an ordinary spatial coordinate (Gonzalez-Ayala et al., 2016).

TIC nevertheless questions whether the time-like coordinate should be assigned independent physical existence rather than treated as a parameter encoding the ordering and duration of change.

The distinction between proper time and coordinate time in relativity likewise does not imply the existence of two different physical substances called time. Proper time is the invariant interval measured along a time-like worldline, whereas coordinate time depends on the chosen coordinate system.

TIC accepts the empirical fact that clocks can register different elapsed durations under different kinematic and gravitational conditions, but interprets these results as differences in the physical rates of clocks and processes rather than as evidence that a separate temporal medium itself flows at different rates. Previous work by the authors has explored this interpretation using alternative transformations (Sorli et al., 2022).

Length contraction requires similar care. In special relativity, Lorentz contraction is not normally interpreted as one part of a moving apparatus physically shrinking relative to another part in the same comoving inertial frame. Objects at rest together retain fixed proper lengths in that frame; contraction appears when spatial lengths are compared between relatively moving frames using simultaneity defined in those frames. Therefore, the two-light-clock argument cannot by itself demonstrate an internal contradiction in special relativity. TIC may still reject the standard interpretation, but its criticism should be directed toward the physical interpretation of relativistic coordinates and clock rates rather than toward a contraction that standard relativity does not predict within a single comoving frame (Sorli & Fisaletti, 2012).

The use of backward-in-time language in relativistic quantum theory should also be stated accurately. Feynman's treatment of positrons can be represented diagrammatically as electrons propagating backward in coordinate time; it does not identify a positron with a proton, nor does the formalism by itself establish literal macroscopic travel into the physical past (Feynman, 1949).

TIC can therefore reject a literal ontology of backward temporal motion without attributing to the formalism a claim it does not make. Proposals involving additional temporal dimensions provide another useful contrast. For example, Kletetschka (2025) has advanced a mathematical framework involving three temporal dimensions.

TIC takes the opposite approach: instead of multiplying temporal dimensions, it seeks to eliminate time as an independently existing physical entity. The existence of mathematically consistent alternatives illustrates why the ontological status of time must be distinguished from the mathematical usefulness of temporal coordinates.

This perspective is also compatible with the broader philosophical motivation expressed in approaches that question fundamental time, including Barbour's discussion of a timeless description of physical reality (Barbour, 1999).

TIC, however, makes a more specific cosmological claim: the universe is proposed to be an eternal system whose physical changes occur in time-invariant space and whose measured durations arise from those changes.

Gödel's rotating cosmological solution demonstrated that Einstein's field equations admit spacetimes containing closed time-like curves under particular global conditions (Gödel, 1949).

This result raised deep questions about the interpretation of time in general relativity, but it does not by itself prove that time is unreal. Hawking later argued for a chronology protection mechanism that would prevent the formation of closed time-like curves under physically realistic conditions (Hawking, 1992).

TIC adopts a stronger position by excluding physical time travel at the ontological level: because past and future are not regarded as independently existing regions, there is no physical domain into which an observer could travel.

The resulting TIC position may be summarized as follows. Relativistic spacetime remains a mathematically powerful predictive framework, but TIC questions whether its temporal coordinate must correspond to a fundamental physical entity. Page–Wootters-type relational time, measured clock-rate differences, neural temporal perception, and the logical difficulties associated with closed time-like curves are treated as converging motivations not proofs for exploring a time-invariant ontology. The empirical adequacy of that ontology must ultimately be judged by quantitative physical predictions. In the cosmological application developed here, TIC combines this time-invariant ontology with an infinite spatial model and with a dynamical quantum-space interpretation of gravitation and galactic processes.

The framework further proposes that the dominant non-baryonic component of the cosmic energy budget is associated with this dynamical spatial substrate and that AGN activity contributes to long-term matter-energy rejuvenation. Conventional cosmology instead attributes galaxy dynamics largely to dark matter and describes the cosmic energy budget through matter and dark-energy components. Observational studies of galaxy rotation remain important constraints on any alternative explanation (Nelson & Williams, 2024).

TIC must therefore demonstrate quantitatively that its superfluid-space mechanism can reproduce rotation curves and other gravitational observations without the standard dark-matter interpretation.

NEWTONIAN PERSPECTIVE ON THE TIME-INVARIANT UNIVERSE

TIC is conceptually aligned with an important feature of Newtonian cosmology: the preference for a universe without a privileged spatial center or boundary. Historical discussions of Newton's cosmological reasoning emphasize that he regarded a finite self-gravitating stellar system as problematic because such a system would possess a preferred center toward which matter could collapse, whereas an unbounded distribution could avoid that particular construction (European Space Agency, 2026; Harrison, 2000).

TIC adopts this Newtonian motivation but extends it into its own model of an eternal, time-invariant universe. Newton's conception of absolute and mathematical time differs from the ontology proposed in TIC. Newton described absolute time as flowing uniformly and independently of external change (Newton, 1864).

TIC retains the usefulness of duration and ordering but rejects the additional assumption that such a flow exists as an independent physical entity. In TIC, the numerical order of material changes and the durations measured by clocks provide the operational content of time, while the underlying physical arena is taken to be time-invariant space.

The Page–Wootters relational approach discussed earlier provides conceptual motivation for separating measurable temporal relations from an externally imposed universal time parameter.

TIC makes the stronger ontological proposal that physical systems do not move through a separately existing temporal dimension. This proposal is not established by the Page–Wootters mechanism alone; rather, it is a defining assumption of TIC whose value must be judged by the physical coherence and empirical performance of the resulting cosmology.

TIC also adopts an infinite spatial universe. Observational constraints indicate that the large-scale spatial curvature of the observable universe is very close to zero (Efstathiou & Gratton, 2020; NASA, 2014; Planck Collaboration, 2020). Such measurements support spatial flatness within observational precision, but they do not by themselves prove that the global universe is infinite, because global topology is not fixed by local curvature measurements alone. Accordingly, infinity should be identified explicitly as a TIC model assumption that is compatible with, but not uniquely demonstrated by, present curvature constraints.

The same distinction between observation and interpretation applies to cosmological redshift and the CMB. Doppler and gravitational frequency shifts are directly testable physical effects, whereas cosmological redshift is derived within the FLRW description of an evolving scale factor. The absence of a laboratory realization of global cosmic expansion does not by itself invalidate FLRW cosmology, but it motivates the central TIC question: can the observed redshift-distance relation and the properties of the CMB be reproduced by a stationary, time-invariant model based on gravitational and vacuum-energy processes? The answer must ultimately come from quantitative comparisons with observations rather than from terminology alone.

For this reason, the scientific merit of TIC depends on explicit falsifiability. The model should be regarded as strengthened

when it specifies observations that could rule it out. These include, among others, the redshift-distance relation, supernova light-curve time dilation, baryon acoustic oscillations, the CMB black-body spectrum and anisotropy structure, primordial element abundances, galaxy population evolution, and the energetics and composition of AGN jets.

A successful TIC formulation must reproduce these observations at least as consistently as the standard model while retaining its defining assumptions of a non-expanding, eternal, time-invariant universe.

The present article therefore does not classify the Big Bang model as pseudoscientific. Standard cosmology is a falsifiable and extensively tested theoretical framework. The narrower conclusion advanced here is that some of its ontological interpretations particularly an absolute physical beginning and the independent physical existence of cosmic time are not direct observations and may be reconsidered. TIC is proposed as one such reconsideration (Sorli, 2026).

CONCLUSIONS

This study has re-examined the standard Big Bang model from a Newtonian and empirically oriented perspective while developing Time-Invariant Cosmology (TIC) as an alternative interpretative framework. The central TIC premise has been preserved throughout: the universe is proposed to be eternal and uncreated, universal space is time-invariant, and time is treated as the measured duration and numerical ordering of physical change rather than as an independently existing physical entity. The analysis has distinguished between the observational successes of modern cosmology and the additional ontological interpretations attached to those observations.

Classical singularities are treated as limiting features of theoretical extrapolation rather than directly observed physical objects, while inflation is recognized as a developed theoretical framework whose earliest conditions are not directly accessible to experiment. TIC avoids the need for an absolute cosmological beginning by postulating a universe in long-term dynamic equilibrium.

Within TIC, cosmological redshift is investigated primarily in relation to gravitational and vacuum-energy effects, and the

CMB is interpreted as a phenomenon associated with the presently existing energetic substrate of space. The paper has also proposed a rejuvenating role for active galactic nuclei, in which compact galactic systems participate in the conversion and redistribution of matter and energy through jets and outflows. These are distinctive TIC hypotheses and require quantitative confrontation with astronomical data.

The treatment of time constitutes the conceptual core of the proposed model. Relational approaches to time in quantum theory, clock-rate measurements, and the distinction between mathematical coordinates and physical ontology motivate the TIC proposal that temporal coordinates need not correspond to an independently existing physical substance. Relativistic spacetime remains an effective mathematical framework, but TIC interprets physical change as occurring in time-invariant space, with duration emerging from the measurement of ordered processes.

The present revision also clarifies the mathematical and empirical obligations of the model. Spatial flatness does not by itself exclude an expanding FLRW universe; Wien's law alone does not invalidate the standard red-shifting interpretation of the CMB; and the historical notation $x^4 = ict$ is a coordinate convention rather than a mathematical error.

Preserving the aims of TIC therefore requires its critique of standard cosmology to rest on physical predictions and observational discrimination rather than on claims that are not mathematically required by the standard framework.

Accordingly, the most important next step for TIC is the formulation of a compact set of quantitative and falsifiable predictions. A scientifically competitive time-invariant cosmology should specify where its predictions differ from Λ CDM and identify observations capable of distinguishing the two frameworks. In this sense, the principal contribution of TIC is not merely its rejection of a cosmological beginning, but its attempt to formulate an alternative physical description of how an eternal universe could function.

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