Modulus Time: A Symmetrical Framework for Absolute Time and Cyclic Cosmology

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Abstract

This paper proposes a concept of Modulus Time, denoted as $|T|$, a framework where time is treated as a symmetric quantity with magnitude independent of direction. In contrast to the conventional concept of time, which flows only in the forward direction, Modulus Time integrates two symmetric directions, $+T$ and $-T$, each corresponding to contrasting entropy evolution. This symmetrical property naturally suggests a cyclic cosmological framework, where the universe experiences phases of expansion with increasing entropy ($+T$), followed by contraction with decreasing entropy ($-T$), forming an indefinitely repeating cycle. We discuss the theoretical implications for thermodynamics, causality, and the arrow of time.

1 Introduction

Time is generally treated as a non-discrete, unidirectional quantity progressing from past to future. Nevertheless, many fundamental physical laws are symmetric with respect to time, leaving the nature of the arrow of time as an unresolved problem. In this framework, Modulus Time is introduced to reconcile the symmetry of time with the directional flow of thermodynamics. The specialty of Modulus Time resides in its explicit definition of time as an absolute magnitude $|T|$, separating temporal directionality from magnitude. Unlike conventional models, where time reversal is simply defined as a negation of temporal parameters, Modulus Time considers positive and negative times as symmetric yet physically distinct variables with their own entropy evolution and causal structure.

The key objective of Modulus Time is to formalize a cyclic universe, where the universe undergoes phases of expansion with increasing entropy with respect to positive time ($+T$), followed by phases of contraction with decreasing entropy with respect to negative time ($-T$). Once the universe reaches its maximal expansion or "death", it transitions into a reversed temporal phase under $-T$, effectively 'rewinding' with decreasing entropy, prior to transitioning back to $+T$. This cyclical nature is intrinsic to the definition of time itself, instead of being imposed externally.

2 Conceptual Framework and Mathematical Formulation

2.1 Definition of Modulus Time

$$|T| = \begin{cases} +T, & T \geq 0 \\ -T, & T < 0 \end{cases} \tag{1}$$

The entropy time derivative is:

$$\frac{dS}{dT} = \alpha \, \mathrm{sgn}(T) \tag{2}$$

which is positive for $T > 0$ and negative for $T < 0$.

2.2 Entropy Evolution and Temporal Direction

Entropy S is formulated as a function of Modulus Time $|T|$ and direction sign:

$$S(T) = S_0 + \alpha \, \mathrm{sgn}(T) \, |T| = S_0 + \alpha T \tag{3}$$

where

$$\mathrm{sgn}(T) = \begin{cases} +1, & T > 0 \\ 0, & T = 0 \\ -1, & T < 0 \end{cases}$$

Interpretation:

- For $T > 0$, entropy increases: $S(T) = S_0 + \alpha T$
- For $T < 0$, entropy decreases: $S(T) = S_0 + \alpha T$ (note $T < 0$)
- At $T = 0$, entropy is at baseline: $S(0) = S_0$

2.3 Spatial Curvature Coupling

Assuming spatial curvature K depends on entropy and modulus time:

$$K(|T|) = K_0 + \beta |T| \tag{4}$$

Including sign function:

$$K(|T|) = K_0 - \beta \, \mathrm{sgn}(T) \, |T| = K_0 - \beta T \tag{5}$$

where β is the coupling constant between time and spatial curvature, and K_0 is baseline curvature at $T = 0$.

2.4 Friedmann Equation Adaptation

The Friedmann equation for the cosmic scale factor $a(t)$:

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G\rho}{3} - \frac{K}{a^2} + \frac{\Lambda}{3} \tag{6}$$

Rewriting with modulus time T and curvature $K(T)$:

$$\left(\frac{da}{d|T|}\frac{d|T|}{dT}\frac{1}{a}\right)^2 = \frac{8\pi G\rho}{3} - \frac{K_0 - \beta T}{a^2} + \frac{\Lambda}{3} \tag{7}$$

2.5 Modulus Time-Adapted Acceleration Equation

Standard cosmology:

$$\frac{\ddot{a}}{a} = -4\pi G(\rho + 3p) + \frac{\Lambda}{3} \tag{8}$$

Under Modulus Time (using chain rule for $|T|$):

$$\frac{d^2a}{d|T|^2}\left(\frac{d|T|}{dT}\right)^2 + \frac{da}{d|T|}\frac{d^2|T|}{dT^2} \tag{9}$$

At $T = 0$, $d^2a/d|T|^2 = 0$ and $\text{sgn}(T) = d|T|/dT$, giving:

$$\frac{\ddot{a}}{a} = -4\pi G(\rho + 3p) + \frac{\Lambda}{3} + \frac{\beta}{2a^2} \tag{10}$$

where $\beta/2a^2$ is the Modulus Time curvature coupling term.

2.6 Hubble Parameter

Standard cosmology:

$$H(t) = \frac{\dot{a}}{a} \tag{11}$$

Under Modulus Time:

$$H(T) = \frac{1}{a}\frac{da}{dT} = \frac{1}{a}\frac{da}{dt}\,\text{sgn}(T) \tag{12}$$

2.7 Continuity / Energy Conservation

Standard cosmology:

$$\frac{d\rho}{dt} + 3\frac{\dot{a}}{a}(\rho + p) = 0 \tag{13}$$

Under Modulus Time:

$$\frac{d\rho}{dT} + 3\frac{\dot{a}}{a}(\rho + p) = 0 \tag{14}$$

This preserves energy conservation while accounting for the symmetric flow of Modulus Time.

3 Open Discussion

The Modulus Time framework raises intriguing questions and opens new avenues for future research. It lacks rigorous mathematical formalization, such as in general relativity, quantum field theory, tensorial descriptions, and metric modifications. The suggested entropy reversal under negative time directly corresponds to temporal direction and thermodynamic laws. Experimentally studying entropy decrease, causality, and information flow under modulus time in each $+T$ and $-T$ domain could open new doors in physics.

Analyses of CMB anisotropies, previous negative-time phases, large-scale anomalies, and entropy patterns considering modulus time could test this framework's viability. Since flipping global cosmological time is impossible, analogical test methods such as entropy manipulation, optical analogues, and time-symmetric quantum experiments can mimic negative time.

While time symmetry and cyclic cosmologies have been explored before, Modulus Time explicitly separates the magnitude of time from temporal direction. Comparative studies could refine this framework in the future.

4 Conclusion

Modulus Time offers a symmetrical conceptual framework that considers time as an absolute and directionless quantity yet with distinct physical phenomena. This perspective gives rise to a naturally cyclic cosmological framework with entropy increasing in forward time and decreasing in reversal, opening novel paths for understanding temporal and cosmological phenomena.

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