Time

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2025

Time

Abstract

The T0 model describes a fundamental granulation of spacetime at the sub-Planck scale $= \xi\times$ with $\xi \approx 1.333 \times 10^{-4}$. This work examines the consequences for scale hierarchies, time continuity, and the mathematical completeness of various gravitational theories. The time-mass duality $T(x,t) \cdot m(x,t) = 1$ requires both fields to be coupled and variable, while the fundamental ξ-asymmetry enables all developmental processes.

1 Granulation as Fundamental Principle of Reality

1.1 Minimum Length Scale

The T0 model introduces a fundamental length scale deeper than the Planck length:

$$= \xi \times \approx \frac{4}{3} \times 10^{-4} \times 1.616 \times 10^{-35} \text{ m} \approx 2.155 \times 10^{-39} \text{ m} \tag{1}$$

Significance of :

- Absolute physical lower limit for spatial structures
- Granulated spacetime structure - not continuous
- Sub-Planck physics with new fundamental laws
- Universal scale for all physical phenomena

1.2 The Extreme Scale Hierarchy

From to cosmological scales extends a hierarchy of over 60 orders of magnitude:

$$\approx 10^{-39} \text{ m} \quad \text{(Sub-Planck minimum)} \tag{2}$$
$$\approx 10^{-35} \text{ m} \quad \text{(Planck length)} \tag{3}$$
$$L_{\text{Casimir}} \approx 100 \text{ micrometers} \quad \text{(Casimir scale)} \tag{4}$$
$$L_{\text{Atom}} \approx 10^{-10} \text{ m} \quad \text{(Atomic scale)} \tag{5}$$
$$L_{\text{Macro}} \approx 1 \text{ m} \quad \text{(Human scale)} \tag{6}$$
$$L_{\text{Cosmo}} \approx 10^{26} \text{ m} \quad \text{(Cosmological scale)} \tag{7}$$

1.3 Casimir Scale as Evidence of Granulation

At the Casimir characteristic scale, first measurable effects appear:

$$L_\xi \approx \frac{1}{\sqrt{\xi \times}} \approx 100 \text{ micrometers} \tag{8}$$

Experimental evidence:

- Deviations from $1/d^4$ law at distances ≈ 10 nm
- ξ-corrections in Casimir force measurements
- Limits of continuum physics become visible

2 Limit Systems and Scale Hierarchies

2.1 Three-Scale Hierarchy

The T0 model organizes all physical scales into three fundamental domains:

1. **-domain**: Granulated physics, universal laws
2. **Planck domain**: Quantum gravity, transition dynamics
3. **Macro domain**: Classical physics with ξ-corrections

2.2 Relational Number System

Prime number ratios organize particles into natural generations:

- **3-limit**: u-, d-quarks (1st generation)
- **5-limit**: c-, s-quarks (2nd generation)
- **7-limit**: t-, b-quarks (3rd generation)

The next prime number (11) leads to ξ^{11}-corrections $\approx 10^{-44}$, which lie below the Planck scale.

2.3 CP Violation from Universal Asymmetry

The ξ-asymmetry explains:

- CP violation in weak interactions
- Matter-antimatter asymmetry in the universe
- Chiral symmetry breaking in nature

3 Fundamental Asymmetry as Motion Principle

3.1 The Universal ξ-Constant

$$\xi = \frac{4}{3} \times 10^{-4} \approx 1.333 \times 10^{-4} \tag{9}$$

Origin: Geometric 4/3-constant from optimal 3D space packing
Effect: Universal asymmetry enabling all development

3.2 Eternal Universe Without Big Bang

The T0 model describes an eternal, infinite, non-expanding universe:

- No beginning, no end - timeless existence
- Heisenberg's uncertainty principle forbids Big Bang: $\Delta E \times \Delta t \geq \hbar/2$
- Structured development instead of chaotic explosion
- Continuous ξ-field dynamics instead of Big Bang

3.3 Time Exists Only After Field-Asymmetry Excitation

Hierarchy of time emergence:

1. **Timeless universe**: Perfect symmetry, no time
2. **ξ-asymmetry arises**: Symmetry breaking activates time field
3. **Time-energy duality**: $T(x,t) \cdot E(x,t) = 1$ becomes active
4. **Manifested time**: Local time emerges through field dynamics
5. **Directed time**: Thermodynamic arrow of time stabilizes

Time is not fundamental but emergent from field asymmetry.

4 Hierarchical Structure: Universe > Field > Space

4.1 The Fundamental Order Hierarchy

Universe (highest order level):

- Superordinate structure with eternal, infinite properties
- Global organizational principles determine everything below
- ξ-asymmetry as universal guiding structure
- Thermodynamic overall balance of all processes

Field (middle organizational level):

- Universal ξ-field as mediator between universe and space
- Local dynamics within global constraints
- Time-energy duality as field principle
- Structure-forming processes through asymmetry

Space (manifestation level):

- 3D geometry as stage for field manifestations
- Granulation at -scale
- Local interactions between field excitations

4.2 Causal Downward Coupling

$$\text{UNIVERSE} \rightarrow \text{FIELD} \rightarrow \text{SPACE} \rightarrow \text{PARTICLES} \tag{10}$$

The universe is not just the sum of its spatial parts. Superordinate properties emerge only at the highest level. The ξ-constant is universal, not a space property.

5 Continuous Time Beyond Certain Scales

5.1 The Crucial Scale Hierarchy of Time

In the T0 model, different time domains exist with fundamentally different properties. The further we move from , the more continuous and constant time becomes.

5.1.1 Granulated Zone (below)

$$= \xi \times \approx 2.155 \times 10^{-39} \text{ m} \tag{11}$$

- Time is discretely granulated, not continuous
- Chaotic quantum fluctuations dominate
- Physics loses classical meaning
- All fundamental forces equally strong

5.1.2 Transition Zone (around)

- Time-mass duality $T \cdot m = 1$ becomes fully active
- Intensive interaction of all fields
- Transition from granulated to continuous

5.1.3 Continuous Zone (above)

Central Insight

$$\text{Distance to } \uparrow \quad \Rightarrow \quad \text{Time continuity} \uparrow \quad \Rightarrow \quad \text{Constant direction} \uparrow \tag{12}$$

- Beyond a certain point, time becomes continuous
- Constant directed flow direction emerges
- The greater the distance to , the more stable the time direction
- Emergent classical physics with ξ-corrections

5.2 Quantitative Scaling of Time Continuity

Time continuity as function of distance to :

$$\text{Time continuity} \propto \log\left(\frac{L}{}\right) \quad \text{for } L \gg \tag{13}$$

Practical scales:

$$L = 10^{-35} \text{ m (Planck)}: \quad \text{Still granulated} \tag{14}$$
$$L = 10^{-15} \text{ m (Nuclear)}: \quad \text{Transition to continuity} \tag{15}$$
$$L = 10^{-10} \text{ m (Atomic)}: \quad \text{Practically continuous} \tag{16}$$
$$L = 10^{-3} \text{ m (mm)}: \quad \text{Completely continuous, constant direction} \tag{17}$$
$$L = 1 \text{ m (Meter)}: \quad \text{Perfectly linear, directed time} \tag{18}$$

5.3 Thermodynamic Arrow of Time

Scale-dependent entropy:

- **Granulated level ()**: Maximum entropy, perfect symmetry
- **Transition level**: Entropy gradients emerge
- **Continuous level**: Second law becomes active
- **Macroscopic level**: Irreversible time direction

6 Practical vs. Fundamental Physics

6.1 Time is Practically Experienced as Constant

De facto for us: Time flows constantly in our experience domain

- **Local scales (m to km)**: Time is practically perfectly linear and constant
- **Measurable variations**: Only under extreme conditions (GPS satellites, particle accelerators)
- **Everyday physics**: Time constancy is a good approximation

6.2 Speed of Light as Clear Upper Limit

Observed reality:

- $c = 299,792,458$ m/s is measurable upper limit for information transfer
- **Causality**: No signals faster than c observed
- **Relativistic effects**: Clearly measurable at $v \to c$
- **Particle accelerators**: Confirm c-limit daily

6.3 Resolution of the Apparent Contradiction

Macroscopic level (our world):

$$L = 1 \text{ m to } 10^6 \text{ m (km range)} \tag{19}$$

- Time flows constantly: $dt/dt_0 \approx 1 + 10^{-16}$ (immeasurable)
- c is practically constant: $\Delta c/c \approx 10^{-16}$ (immeasurable)
- Einstein physics works perfectly

Fundamental level (T0 model):

$$= 10^{-39} \text{ m to } = 10^{-35} \text{ m} \tag{20}$$

- Time-mass duality: $T \cdot m = 1$ is fundamental
- c is ratio: $c = L/T$ (must be variable)
- Mathematical consistency requires coupled variation

These variations are 10^6 times smaller than our best measurement precision!

7 Gravitation: Mass Variation vs. Space Curvature

7.1 Two Equivalent Interpretations

Einstein interpretation:

- m = constant (fixed mass)
- $g_{\mu\nu}$ = variable (curved spacetime)
- Mass causes space curvature

T0 interpretation:

- $m(x,t)$ = variable (dynamic mass)
- $g_{\mu\nu}$ = fixed (flat Euclidean space)
- Mass varies locally through ξ-field

7.2 Important Insight: We Don't Know!

Attention - Fundamental Point

We DO NOT KNOW whether mass causes space curvature or whether mass itself varies!
This is an assumption, not a proven fact!

Both interpretations are equally valid:
Einstein assumption:

$$\text{Mass/energy} \to \text{Space curvature} \to \text{Gravitation} \tag{21}$$

$$G_{\mu\nu} = 8\pi T_{\mu\nu} \tag{22}$$

T0 alternative:

$$\xi\text{-field} \to \text{Mass variation} \to \text{Gravitational effects} \tag{23}$$

$$m(x,t) = m_0 \cdot (1 + \xi \cdot \Phi(x,t)) \tag{24}$$

7.3 Experimental Indistinguishability

All measurements are frequency-based:

- **Clocks**: Hyperfine transition frequencies
- **Scales**: Spring oscillations/resonance frequencies
- **Spectrometers**: Light frequencies and transitions
- **Interferometers**: Phases = frequency integrals

Identical frequency shifts:

$$\text{Einstein}: \quad \nu' = \nu_0\sqrt{1+2\Phi/c^2} \approx \nu_0(1+\Phi/c^2) \tag{25}$$

$$\text{T0}: \quad \nu' = \nu_0 \cdot \frac{m(x,t)}{T(x,t)} \approx \nu_0(1+\Phi/c^2) \tag{26}$$

Only frequency ratios are measurable - absolute frequencies are fundamentally inaccessible!

8 Mathematical Completeness: Both Fields Coupled Variable

8.1 The Correct Mathematical Formulation

Mathematically correct in T0 model:

$$T(x,t) = \text{variable} \quad \text{(Time as dynamic field)} \tag{27}$$

$$m(x,t) = \text{variable} \quad \text{(Mass as dynamic field)} \tag{28}$$

Coupled through fundamental duality:

$$T(x,t) \cdot m(x,t) = 1 \tag{29}$$

Both fields vary TOGETHER:

$$T(x,t) = T_0 \cdot (1 + \xi \cdot \Phi(x,t)) \tag{30}$$

$$m(x,t) = m_0 \cdot (1 - \xi \cdot \Phi(x,t)) \tag{31}$$

8.2 Verification of Mathematical Consistency

Duality check:

$$T(x,t) \cdot m(x,t) = T_0 m_0 \cdot (1+\xi\Phi)(1-\xi\Phi) \tag{32}$$

$$= T_0 m_0 \cdot (1 - \xi^2\Phi^2) \tag{33}$$

$$\approx T_0 m_0 = 1 \quad (\text{for } \xi\Phi \ll 1) \tag{34}$$

Mathematical consistency confirmed!

8.3 Why Both Fields Must Be Variable

Lagrange formalism requires:

$$\delta S = \int \delta\mathcal{L}\, d^4x = 0 \tag{35}$$

Complete variation:

$$\delta\mathcal{L} = \frac{\partial\mathcal{L}}{\partial T}\delta T + \frac{\partial\mathcal{L}}{\partial m}\delta m + \frac{\partial\mathcal{L}}{\partial\partial_\mu T}\delta\partial_\mu T + \frac{\partial\mathcal{L}}{\partial\partial_\mu m}\delta\partial_\mu m \tag{36}$$

For mathematical completeness:

- $\delta T \neq 0$ (Time must be variable)
- $\delta m \neq 0$ (Mass must be variable)
- Both coupled through $T \cdot m = 1$

8.4 Einstein's Arbitrary Constant Setting

Einstein arbitrarily sets:

$$m_0 = \text{constant} \quad \Rightarrow \quad \delta m = 0 \tag{37}$$

Mathematical problem:

- Incomplete variation of the Lagrangian
- Violates variation principle of field theory
- Arbitrary symmetry breaking without justification

8.5 Parameter Elegance

$$\text{Einstein}: \quad m_0, c, G, \hbar, \Lambda, \alpha_{\text{EM}}, \ldots \quad (\gg 10 \text{ free parameters}) \tag{38}$$

$$\text{T0}: \quad \xi \quad (1 \text{ universal parameter}) \tag{39}$$

9 Pragmatic Preference: Variable Mass with Constant Time

9.1 The Pragmatic Alternative for Our Experience Space

As pragmatists, one can certainly prefer:

$$\text{Time}: \quad t = \text{constant} \quad (\text{practical experience}) \tag{40}$$

$$\text{Mass}: \quad m(x,t) = \text{variable} \quad (\text{dynamic adjustment}) \tag{41}$$

Why this is pragmatically sensible:

- Time constancy corresponds to our direct experience
- Mass variation is conceptually easier to imagine
- Practical calculations often become simpler
- Intuitive understandability for applications

9.2 Practical Advantages of Constant Time

In our experienceable space (m to km):

- Time flows linearly and constantly - our direct experience
- Clocks tick uniformly - practical time measurement
- Causal sequences are clearly defined
- Technical applications (GPS, navigation) function

Language convention:

- Time passes constantly
- Mass adapts to the fields
- Matter becomes heavier/lighter depending on location

9.3 Variable Mass as Intuitive Concept

Pragmatic interpretation:

$$m(x) = m_0 \cdot (1 + \xi \cdot \text{Gravitational field}(x)) \tag{42}$$

Intuitive conception:

- Mass increases in strong gravitational fields
- Mass decreases in weaker fields
- Matter feels the local ξ-field
- Dynamic adaptation to environment

9.4 Scientific Legitimacy of Preference

Important Insight

Pragmatic preferences are scientifically justified when both approaches are experimentally equivalent!

Justification:

- Scientifically equivalent to Einstein approach
- Often practically advantageous for applications
- Didactically easier to teach
- Technically more efficient to implement

The choice between constant time + variable mass vs. Einstein is a matter of taste - both are scientifically equally justified!

10 The Eternal Philosophical Boundary

10.1 What the T0 Model Explains

- HOW the ξ-asymmetry works
- WHAT the consequences are
- WHICH laws follow from it
- WHEN time and development emerge

10.2 What the T0 Model CANNOT Explain

The fundamental questions remain:

- WHY does the ξ-asymmetry exist?
- WHERE does the original energy come from?
- WHO/WHAT gave the first impulse?
- WHY does anything exist at all instead of nothing?

10.3 Scientific Humility

The eternal boundary: Every explanation needs unexplained axioms. The ultimate reason always remains mysterious. The that of existence is given, the why remains open.

The elegant shift: The T0 model shifts the mystery to a deeper, more elegant level - but it cannot resolve the fundamental riddle of existence.

And that is good. Because a universe without mystery would be a boring universe.

11 Experimental Predictions and Tests

11.1 Casimir Effect Modifications

- Deviations from $1/d^4$ law at $d \approx 10$ nm
- ξ-corrections in precision measurements
- Frequency-dependent Casimir forces

11.2 Atom Interferometry

- ξ-resonances in quantum interferometers
- Mass variations in gravitational fields
- Time-mass duality in precision experiments

11.3 Gravitational Wave Detection

- ξ-corrections in LIGO/Virgo data
- Modifications of wave dispersion
- Sub-Planck structures in gravitational waves

12 Conclusion: Asymmetry as Engine of Reality

The T0 model shows that granulation, limits, and fundamental asymmetry are inseparably connected with the scale-dependent nature of time:

1. **Granulation** at defines the base scale of all physics
2. **Limit systems** organize particles into natural generations
3. **Fundamental asymmetry** generates time, development, and structure formation
4. **Hierarchical organization** from universe through field to space
5. **Continuous time** emerges beyond certain scales through distance to
6. **Mathematical completeness** requires T0 formulation over Einstein
7. **Experimental indistinguishability** of different interpretations
8. **Pragmatic preferences** are scientifically justified
9. **Philosophical boundaries** remain and preserve the mystery

The ξ-asymmetry is the engine of reality - without it, the universe would remain in perfect, timeless symmetry. With it emerges the entire diversity and dynamics of our observable world.

The T0 model thus offers a unified explanation for fundamental puzzles of physics - from the granulation of spacetime to the emergence of time itself.

13 Mathematical Proof: The Formula $T \cdot m = 1$ Excludes Singularities

13.1 Important Clarification: T as Oscillation Period

ATTENTION: In this analysis, T does not mean the experienced, continuously flowing time, but the **oscillation period** or **characteristic time constant** of a system. This is a fundamental difference:

- T = oscillation period (discrete, characteristic time unit)
- Not: T = continuous time coordinate (our everyday experience)

13.2 The Fundamental Exclusion Property

The equation $T \cdot m = 1$ is not just a mathematical relationship – it is an **exclusion theorem**. Through its algebraic structure, it makes certain states mathematically impossible.

13.3 Proof 1: Exclusion of Infinite Mass

Assumption: There exists an infinite mass $m = \infty$

Mathematical consequence:

$$T \cdot m = 1 \tag{43}$$
$$T \cdot \infty = 1 \tag{44}$$
$$T = \frac{1}{\infty} = 0 \tag{45}$$

Contradiction: $T = 0$ is not in the domain of the equation $T \cdot m = 1$, since:

- The product $0 \cdot \infty$ is mathematically undefined
- The original equation $T \cdot m = 1$ would be violated $(0 \cdot \infty \neq 1)$

Conclusion: $m = \infty$ is excluded by the formula.

13.4 Proof 2: Exclusion of Infinite Time

Assumption: There exists an infinite time $T = \infty$

Mathematical consequence:

$$T \cdot m = 1 \tag{46}$$
$$\infty \cdot m = 1 \tag{47}$$
$$m = \frac{1}{\infty} = 0 \tag{48}$$

Contradiction: $m = 0$ is not in the domain, since:

- The product $\infty \cdot 0$ is mathematically undefined
- The equation $T \cdot m = 1$ would be violated $(\infty \cdot 0 \neq 1)$

Conclusion: $T = \infty$ is excluded by the formula.

13.5 Proof 3: Exclusion of Zero Values

Assumption: There exists $T = 0$ or $m = 0$

Case 1: $T = 0$

$$T \cdot m = 1 \Rightarrow 0 \cdot m = 1 \tag{49}$$

This is impossible for any finite value of m, since $0 \cdot m = 0 \neq 1$.

Case 2: $m = 0$

$$T \cdot m = 1 \Rightarrow T \cdot 0 = 1 \tag{50}$$

This is impossible for any finite value of T, since $T \cdot 0 = 0 \neq 1$.

Conclusion: Both $T = 0$ and $m = 0$ are excluded by the formula.

13.6 Proof 4: Exclusion of Mathematical Singularities

Definition of a singularity: A point where a function becomes undefined or infinite.

Analysis of the function $T = \frac{1}{m}$**:**

Potential singularities could occur at:

- $m = 0$ (division by zero)
- $T \to \infty$ (infinite function values)

Exclusion by the constraint $T \cdot m = 1$**:**

1. **At** $m = 0$**:** The equation $T \cdot m = 1$ cannot be satisfied
2. **At** $T \to \infty$**:** Would require $m \to 0$, which is already excluded

Mathematical proof of singularity freedom:

For every point (T, m) with $T \cdot m = 1$:

$$T = \frac{1}{m} \text{ with } m \in (0, +\infty) \tag{51}$$

$$m = \frac{1}{T} \text{ with } T \in (0, +\infty) \tag{52}$$

Both functions are on their entire domain:

- **Continuous**
- **Differentiable**
- **Finite Well-defined**

13.7 The Algebraic Protection Function

The equation $T \cdot m = 1$ acts like an **algebraic protection** against singularities:

13.7.1 Automatic Correction

$$\text{If } m \text{ becomes very small} \Rightarrow T \text{ automatically becomes very large} \tag{53}$$

$$\text{If } T \text{ becomes very small} \Rightarrow m \text{ automatically becomes very large} \tag{54}$$

$$\text{But: } T \cdot m \text{ always remains exactly 1} \tag{55}$$

13.7.2 Mathematical Stability

$$\lim_{m \to 0^+} T = +\infty, \text{ but } T \cdot m = 1 \text{ remains satisfied} \tag{56}$$

$$\lim_{T \to 0^+} m = +\infty, \text{ but } T \cdot m = 1 \text{ remains satisfied} \tag{57}$$

The constraint **forces** the variables into a finite, well-defined region.

13.8 Proof 5: Positive Definiteness

Theorem: All solutions of $T \cdot m = 1$ are positive.

Proof:

$$T \cdot m = 1 > 0 \tag{58}$$

Since the product is positive, both factors must have the same sign.

Exclusion of negative values:

- If $T < 0$ and $m < 0$, then $T \cdot m > 0$, but physically meaningless
- If $T > 0$ and $m < 0$, then $T \cdot m < 0 \neq 1$
- If $T < 0$ and $m > 0$, then $T \cdot m < 0 \neq 1$

Conclusion: Only $T > 0$ and $m > 0$ satisfy the equation.

13.9 The Fundamental Insight About Time and Continuity

Important physical clarification:

The formula $T \cdot m = 1$ describes **discrete, characteristic properties** of systems, not the continuous time flow of our experience. This means:

13.9.1 What $T \cdot m = 1$ does NOT state:

- „Time stands still“ ($T = 0$)
- „Processes take infinitely long“ ($T = \infty$)
- „The time flow is interrupted“
- „Our experienced time disappears“

13.9.2 What $T \cdot m = 1$ actually describes:

- **Oscillation periods** have mathematical limits
- **Characteristic time constants** cannot become arbitrary
- **Discrete time units** stand in fixed relation to mass
- **Periodic processes** follow the constraint $T \cdot m = 1$

13.9.3 The continuous time flow remains unaffected

The continuous time coordinate t (our „arrow time“) is **not affected** by this relationship. $T \cdot m = 1$ regulates only the **intrinsic time scales** of physical systems, not the superordinate time flow in which these systems exist.

Important insight about our time perception:

Our continuous time perception could practically be only a **tiny excerpt** of a much larger period – an oscillation period so immense that it far exceeds anything humans could ever experience or conceive.

Conceivable orders of magnitude:

- **Human life:** $\sim 10^2$ years
- **Human history:** $\sim 10^4$ years
- **Earth age:** $\sim 10^9$ years
- **Universe age:** $\sim 10^{10}$ years **Possible cosmic period:** 10^{50}, 10^{100} or even larger time scales

In such a scenario, our entire observable universe would experience only an **infinitesimal small fraction** of a fundamental oscillation period. For us, time appears linear and continuous because we perceive only a vanishingly small section of a huge cosmic „oscillation“.

Analogy: Just as a bacterium on a clock hand would perceive the movement as „straight ahead“, although it moves on a circular path, we might experience „linear time“, although we are in a gigantic periodic structure.

This perspective shows that $T \cdot m = 1$ and our time perception can operate on completely different scales without contradicting each other.

13.10 Cosmological Implications

This viewpoint opens new possibilities:

What we observe as cosmic development and change could be only a **small section** in a much larger cyclic pattern that follows the fundamental relationship $T \cdot m = 1$.

Possible cosmic structure:

- **Local time perception:** Linear, continuous (our experience domain)
- **Middle time scales:** Observable cosmic developments
- **Fundamental time scale:** Gigantic period according to $T \cdot m = 1$

Implications:

- Nature could be organized in **layered-periodic** fashion
- Different time scales follow different regularities
- $T \cdot m = 1$ could be the **master constraint** for the largest scale
- Our observable cosmic development would be a fragment of a cyclic system

This interpretation shows how mathematical constraints ($T \cdot m = 1$) and physical observations (linear time perception) can coexist in a **hierarchical time model**.

13.11 Conclusion: Mathematical Certainty

The formula $T \cdot m = 1$ is not just an equation – it is an **existence proof** for singularity-free physics. It proves mathematically that:

- **Infinite masses do not exist**
- **Infinite oscillation periods do not exist**

- **Zero masses are excluded**
- **Zero oscillation periods are excluded**
- **Singularities in characteristic time scales cannot occur**

Mathematics itself protects physics from singularities – without affecting the continuous time flow.

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