

# T0 Model: Granulation, Limits and Fundamental Asymmetry

Johann Pascher

November 28, 2025

## Abstract

The T0 model describes a fundamental granulation of spacetime at the sub-Planck scale  $\ell_0 = \xi \times \ell_P$  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  $\xi$ -asymmetry enables all developmental processes.

## Contents

1	Granulation as Fundamental Principle of Reality	2
1.1	Minimum Length Scale $\ell_0$	2
1.2	The Extreme Scale Hierarchy	2
1.3	Casimir Scale as Evidence of Granulation	2
2	Limit Systems and Scale Hierarchies	2
2.1	Three-Scale Hierarchy	2
2.2	Relational Number System	3
2.3	CP Violation from Universal Asymmetry	3
3	Fundamental Asymmetry as Motion Principle	3
3.1	The Universal $\xi$ -Constant	3
3.2	Eternal Universe Without Big Bang	3
3.3	Time Exists Only After Field-Asymmetry Excitation	4
4	Hierarchical Structure: Universe > Field > Space	4
4.1	The Fundamental Order Hierarchy	4
4.2	Causal Downward Coupling	4
5	Continuous Time Beyond Certain Scales	5
5.1	The Crucial Scale Hierarchy of Time	5
5.1.1	Granulated Zone (below $\ell_0$ )	5
5.1.2	Transition Zone (around $\ell_0$ )	5
5.1.3	Continuous Zone (above $\ell_0$ )	5
5.2	Quantitative Scaling of Time Continuity	5

5.3	Thermodynamic Arrow of Time . . . . .	6
6	Practical vs. Fundamental Physics . . . . .	6
6.1	Time is Practically Experienced as Constant . . . . .	6
6.2	Speed of Light as Clear Upper Limit . . . . .	6
6.3	Resolution of the Apparent Contradiction . . . . .	6
7	Gravitation: Mass Variation vs. Space Curvature . . . . .	7
7.1	Two Equivalent Interpretations . . . . .	7
7.2	Important Insight: We Don't Know! . . . . .	7
7.3	Experimental Indistinguishability . . . . .	7
8	Mathematical Completeness: Both Fields Coupled Variable . . . . .	8
8.1	The Correct Mathematical Formulation . . . . .	8
8.2	Verification of Mathematical Consistency . . . . .	8
8.3	Why Both Fields Must Be Variable . . . . .	8
8.4	Einstein's Arbitrary Constant Setting . . . . .	9
8.5	Parameter Elegance . . . . .	9
9	Pragmatic Preference: Variable Mass with Constant Time . . . . .	9
9.1	The Pragmatic Alternative for Our Experience Space . . . . .	9
9.2	Practical Advantages of Constant Time . . . . .	9
9.3	Variable Mass as Intuitive Concept . . . . .	10
9.4	Scientific Legitimacy of Preference . . . . .	10
10	The Eternal Philosophical Boundary . . . . .	10
10.1	What the T0 Model Explains . . . . .	10
10.2	What the T0 Model CANNOT Explain . . . . .	11
10.3	Scientific Humility . . . . .	11
11	Experimental Predictions and Tests . . . . .	11
11.1	Casimir Effect Modifications . . . . .	11
11.2	Atom Interferometry . . . . .	11
11.3	Gravitational Wave Detection . . . . .	11
12	Conclusion: Asymmetry as Engine of Reality . . . . .	12
13	Mathematical Proof: The Formula $T \cdot m = 1$ Excludes Singularities . . . . .	12
13.1	Important Clarification: $T$ as Oscillation Period . . . . .	12
13.2	The Fundamental Exclusion Property . . . . .	12
13.3	Proof 1: Exclusion of Infinite Mass . . . . .	13
13.4	Proof 2: Exclusion of Infinite Time . . . . .	13
13.5	Proof 3: Exclusion of Zero Values . . . . .	13
13.6	Proof 4: Exclusion of Mathematical Singularities . . . . .	14
13.7	The Algebraic Protection Function . . . . .	14
13.7.1	Automatic Correction . . . . .	14
13.7.2	Mathematical Stability . . . . .	14
13.8	Proof 5: Positive Definiteness . . . . .	15
13.9	The Fundamental Insight About Time and Continuity . . . . .	15
13.9.1	What $T \cdot m = 1$ does NOT state: . . . . .	15

13.9.2 What $T \cdot m = 1$ actually describes: . . . . .	15
13.9.3 The continuous time flow remains unaffected . . . . .	15
13.10Cosmological Implications . . . . .	16
13.11Conclusion: Mathematical Certainty . . . . .	16

# 1 Granulation as Fundamental Principle of Reality

## 1.1 Minimum Length Scale $\ell_0$

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

$$\ell_0 = \xi \times \ell_P \approx \frac{4}{3} \times 10^{-4} \times 1.616 \times 10^{-35} \text{ m} \approx 2.155 \times 10^{-39} \text{ m} \quad (1)$$

**Significance of  $\ell_0$ :**

- 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  $\ell_0$  to cosmological scales extends a hierarchy of over 60 orders of magnitude:

$$\ell_0 \approx 10^{-39} \text{ m} \quad (\text{Sub-Planck minimum}) \quad (2)$$

$$\ell_P \approx 10^{-35} \text{ m} \quad (\text{Planck length}) \quad (3)$$

$$L_{\text{Casimir}} \approx 100 \text{ micrometers} \quad (\text{Casimir scale}) \quad (4)$$

$$L_{\text{Atom}} \approx 10^{-10} \text{ m} \quad (\text{Atomic scale}) \quad (5)$$

$$L_{\text{Macro}} \approx 1 \text{ m} \quad (\text{Human scale}) \quad (6)$$

$$L_{\text{Cosmo}} \approx 10^{26} \text{ m} \quad (\text{Cosmological scale}) \quad (7)$$

## 1.3 Casimir Scale as Evidence of Granulation

At the Casimir characteristic scale, first measurable effects appear:

$$L_\xi \approx \frac{1}{\sqrt{\xi \times \ell_P}} \approx 100 \text{ micrometers} \quad (8)$$

**Experimental evidence:**

- Deviations from  $1/d^4$  law at distances  $\approx 10 \text{ nm}$
- $\xi$ -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.  **$\ell_0$ -domain:** Granulated physics, universal laws

- 2. **Planck domain:** Quantum gravity, transition dynamics
- 3. **Macro domain:** Classical physics with  $\xi$ -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  $\xi^{11}$ -corrections  $\approx 10^{-44}$ , which lie below the Planck scale.

## 2.3 CP Violation from Universal Asymmetry

The  $\xi$ -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 $\xi$ -Constant

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

**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  $\xi$ -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.  **$\xi$ -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
- $\xi$ -asymmetry as universal guiding structure
- Thermodynamic overall balance of all processes

Field (middle organizational level):

- Universal  $\xi$ -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  $\ell_0$ -scale
- Local interactions between field excitations

### 4.2 Causal Downward Coupling

$$\text{UNIVERSE} \rightarrow \text{FIELD} \rightarrow \text{SPACE} \rightarrow \text{PARTICLES} \quad (10)$$

The universe is not just the sum of its spatial parts. Superordinate properties emerge only at the highest level. The  $\xi$ -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  $\ell_0$ , the more continuous and constant time becomes.

#### 5.1.1 Granulated Zone (below $\ell_0$ )

$$\ell_0 = \xi \times \ell_P \approx 2.155 \times 10^{-39} \text{ m} \quad (11)$$

- 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 $\ell_0$ )

- 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 $\ell_0$ )

##### Central Insight

$$\text{Distance to } \ell_0 \uparrow \Rightarrow \text{Time continuity } \uparrow \Rightarrow \text{Constant direction } \uparrow \quad (12)$$

- Beyond a certain point, time becomes continuous
- Constant directed flow direction emerges
- The greater the distance to  $\ell_0$ , the more stable the time direction
- Emergent classical physics with  $\xi$ -corrections

### 5.2 Quantitative Scaling of Time Continuity

Time continuity as function of distance to  $\ell_0$ :

$$\text{Time continuity} \propto \log \left( \frac{L}{\ell_0} \right) \quad \text{for } L \gg \ell_0 \quad (13)$$

Practical scales:

$$L = 10^{-35} \text{ m (Planck)} : \text{ Still granulated} \quad (14)$$

$$L = 10^{-15} \text{ m (Nuclear)} : \text{ Transition to continuity} \quad (15)$$

$$L = 10^{-10} \text{ m (Atomic)} : \text{ Practically continuous} \quad (16)$$

$$L = 10^{-3} \text{ m (mm)} : \text{ Completely continuous, constant direction} \quad (17)$$

$$L = 1 \text{ m (Meter)} : \text{ Perfectly linear, directed time} \quad (18)$$

### 5.3 Thermodynamic Arrow of Time

Scale-dependent entropy:

- **Granulated level** ( $\ell_0$ ): 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  $v \rightarrow c$
- **Particle accelerators**: Confirm  $c$ -limit daily

### 6.3 Resolution of the Apparent Contradiction

Macroscopic level (our world):

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

- 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):**

$$\ell_0 = 10^{-39} \text{ m to } \ell_P = 10^{-35} \text{ m} \quad (20)$$

- 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:**

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

**T0 interpretation:**

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

$$\text{Mass/energy} \rightarrow \text{Space curvature} \rightarrow \text{Gravitation} \quad (21)$$

$$G_{\mu\nu} = 8\pi T_{\mu\nu} \quad (22)$$

**T0 alternative:**

$$\xi\text{-field} \rightarrow \text{Mass variation} \rightarrow \text{Gravitational effects} \quad (23)$$

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

### 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:**

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

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

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:

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

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

**Coupled through fundamental duality:**

$$T(x, t) \cdot m(x, t) = 1 \quad (29)$$

**Both fields vary TOGETHER:**

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

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

### 8.2 Verification of Mathematical Consistency

**Duality check:**

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

$$= T_0 m_0 \cdot (1 - \xi^2 \Phi^2) \quad (33)$$

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

Mathematical consistency confirmed!

### 8.3 Why Both Fields Must Be Variable

**Lagrange formalism requires:**

$$\delta S = \int \delta \mathcal{L} d^4x = 0 \quad (35)$$

**Complete variation:**

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

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:

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

**Mathematical problem:**

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

## 8.5 Parameter Elegance

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

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

# 9 Pragmatic Preference: Variable Mass with Constant Time

## 9.1 The Pragmatic Alternative for Our Experience Space

As pragmatists, one can certainly prefer:

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

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

**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:**

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

**Intuitive conception:**

- Mass increases in strong gravitational fields
- Mass decreases in weaker fields
- Matter feels the local  $\xi$ -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  $\xi$ -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  $\xi$ -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
- $\xi$ -corrections in precision measurements
- Frequency-dependent Casimir forces

## 11.2 Atom Interferometry

- $\xi$ -resonances in quantum interferometers
- Mass variations in gravitational fields
- Time-mass duality in precision experiments

## 11.3 Gravitational Wave Detection

- $\xi$ -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  $\ell_0$  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  $\ell_0$
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  $\xi$ -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:**

$$T \cdot m = 1 \quad (43)$$

$$T \cdot \infty = 1 \quad (44)$$

$$T = \frac{1}{\infty} = 0 \quad (45)$$

**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:**

$$T \cdot m = 1 \quad (46)$$

$$\infty \cdot m = 1 \quad (47)$$

$$m = \frac{1}{\infty} = 0 \quad (48)$$

**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:**  $T = 0$

$$T \cdot m = 1 \Rightarrow 0 \cdot m = 1 \quad (49)$$

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

**Case 2:**  $m = 0$

$$T \cdot m = 1 \Rightarrow T \cdot 0 = 1 \quad (50)$$

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)
- $T \rightarrow \infty$  (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**  $T \rightarrow \infty$ : Would require  $m \rightarrow 0$ , which is already excluded

**Mathematical proof of singularity freedom:**

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

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

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

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

$$\text{If } m \text{ becomes very small} \Rightarrow T \text{ automatically becomes very large} \quad (53)$$

$$\text{If } T \text{ becomes very small} \Rightarrow m \text{ automatically becomes very large} \quad (54)$$

$$\text{But: } T \cdot m \text{ always remains exactly } 1 \quad (55)$$

### 13.7.2 Mathematical Stability

$$\lim_{m \rightarrow 0^+} T = +\infty, \text{ but } T \cdot m = 1 \text{ remains satisfied} \quad (56)$$

$$\lim_{T \rightarrow 0^+} m = +\infty, \text{ but } T \cdot m = 1 \text{ remains satisfied} \quad (57)$$

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:**

$$T \cdot m = 1 > 0 \quad (58)$$

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.

## References

- [1] J. Pascher, *T0 Model: Dimensionally Consistent Reference - Field-Theoretic Derivation of the  $\beta$ -Parameter*, 2025.
- [2] J. Pascher, *From Time Dilation to Mass Variation: Mathematical Core Formulations of Time-Mass Duality Theory*, 2025.
- [3] A. Einstein, *The Field Equations of Gravitation*, Proceedings of the Prussian Academy of Sciences, 844–847, 1915.
- [4] M. Planck, *On the Theory of the Energy Distribution Law of the Normal Spectrum*, Proceedings of the German Physical Society, 2, 237–245, 1900.
- [5] H. B. G. Casimir, *On the attraction between two perfectly conducting plates*, Proceedings of the Royal Netherlands Academy of Arts and Sciences, 51, 793–795, 1948.