

# SI Units

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## **Abstract**

T0-Theory achieves complete parameter freedom: Only the geometric parameter  $\xi = \frac{4}{3} \times 10^{-4}$  is fundamental. All physical constants are either derived from  $\xi$  or represent unit definitions. This document provides the complete derivation chain including the gravitational constant  $G$ , the Planck length  $l_P$ , and the Boltzmann constant  $k_B$ . The SI reform 2019 unknowingly implemented the unique calibration that is consistent with this geometric foundation.

# 1 The Geometric Foundation

## 1.1 Single Fundamental Parameter

$$\boxed{\xi = \frac{4}{3} \times 10^{-4}} \quad (1)$$

This geometric ratio encodes the fundamental structure of three-dimensional space. All physical quantities emerge as derivable consequences.

## 1.2 Complete Derivation Framework

Detailed mathematical derivations are available at:

<https://github.com/jpascher/T0-Time-Mass-Duality/tree/main/2/pdf>

# 2 Derivation of the Gravitational Constant from $\xi$

## 2.1 The Fundamental T0 Gravitational Relation

### Starting point of T0 gravity theory:

T0-Theory postulates a fundamental geometric relationship between the characteristic length parameter  $\xi$  and the gravitational constant:

$$\xi = 2\sqrt{G \cdot m_{\text{char}}} \quad (2)$$

where  $m_{\text{char}}$  represents a characteristic mass of the theory.

### Physical interpretation:

- $\xi$  encodes the geometric structure of space
- $G$  describes the coupling between geometry and matter
- $m_{\text{char}}$  sets the characteristic mass scale

## 2.2 Resolution for the Gravitational Constant

Solving equation (2) for  $G$ :

$$\boxed{G = \frac{\xi^2}{4m_{\text{char}}}} \quad (3)$$

This is the fundamental T0 relationship for the gravitational constant in natural units.

### 2.3 Choice of Characteristic Mass

**The electron mass is also derived from  $\xi$ :**

T0-Theory uses the electron mass as the characteristic scale:

$$m_{\text{char}} = m_e = 0.511 \text{ MeV} \quad (4)$$

**Critical point:** The electron mass itself is not an independent parameter, but is derived from  $\xi$  through the T0 mass quantization formula:

$$m_e = \frac{f(1, 0, 1/2)^2}{\xi^2} \cdot S_{T0} \quad (5)$$

where  $f(n, l, j)$  is the geometric quantum number factor and  $S_{T0} = 1 \text{ MeV}/c^2$  is the predicted scaling factor.

Therefore, the entire derivation chain  $\xi \rightarrow m_e \rightarrow G \rightarrow l_P$  depends only on  $\xi$  as the single fundamental input.

### 2.4 Dimensional Analysis in Natural Units

**Dimensional check in natural units ( $\hbar = c = 1$ ):**

In natural units:

$$[M] = [E] \quad (\text{from } E = mc^2 \text{ with } c = 1) \quad (6)$$

$$[L] = [E^{-1}] \quad (\text{from } \lambda = \hbar/p \text{ with } \hbar = 1) \quad (7)$$

$$[T] = [E^{-1}] \quad (\text{from } \omega = E/\hbar \text{ with } \hbar = 1) \quad (8)$$

The gravitational constant has the dimension:

$$[G] = [M^{-1}L^3T^{-2}] = [E^{-1}][E^{-3}][E^2] = [E^{-2}] \quad (9)$$

Checking equation (3):

$$[G] = \frac{[\xi^2]}{[m_e]} = \frac{[1]}{[E]} = [E^{-1}] \neq [E^{-2}] \quad (10)$$

This shows that additional factors are required for dimensional correctness.

### 2.5 Complete Formula with Conversion Factors

Complete gravitational constant formula:

$$G_{\text{SI}} = \frac{\xi_0^2}{4m_e} \times C_{\text{conv}} \times K_{\text{frak}}$$

(11)

where:

- $\xi_0 = 1.333 \times 10^{-4}$  (geometric parameter)

- $m_e = 0.511 \text{ MeV}$  (electron mass, derived from  $\xi$ )
- $C_{\text{conv}} = 7.783 \times 10^{-3}$  (systematically derived from  $\hbar, c$ )
- $K_{\text{frak}} = 0.986$  (fractal quantum spacetime correction)

**Result:**

$$G_{\text{SI}} = 6.674 \times 10^{-11} \text{ m}^3 / (\text{kg} \cdot \text{s}^2) \quad (12)$$

with  $< 0.0002\%$  deviation from CODATA-2018 value.

### 3 Derivation of the Planck Length from $G$ and $\xi$

#### 3.1 The Planck Length as Fundamental Reference

**Definition of the Planck length:**

In standard physics, the Planck length is defined as:

$$l_P = \sqrt{\frac{\hbar G}{c^3}} \quad (13)$$

In natural units ( $\hbar = c = 1$ ) this simplifies to:

$$l_P = \sqrt{G} = 1 \quad (\text{natural units}) \quad (14)$$

**Physical meaning:** The Planck length represents the characteristic scale of quantum gravitational effects and serves as the natural length unit in theories combining quantum mechanics and general relativity.

#### 3.2 T0 Derivation: Planck Length from $\xi$ Only

**Complete derivation chain:**

Since  $G$  is derived from  $\xi$  via equation (3):

$$G = \frac{\xi^2}{4m_e} \quad (15)$$

the Planck length follows directly:

$$l_P = \sqrt{G} = \sqrt{\frac{\xi^2}{4m_e}} = \frac{\xi}{2\sqrt{m_e}} \quad (16)$$

In natural units with  $m_e = 0.511 \text{ MeV}$ :

$$l_P = \frac{1.333 \times 10^{-4}}{2\sqrt{0.511}} \approx 9.33 \times 10^{-5} \quad (\text{natural units}) \quad (17)$$

**Conversion to SI units:**

$$l_P = 1.616 \times 10^{-35} \text{ m} \quad (18)$$

#### 3.3 The Characteristic T0 Length Scale

**Connection between  $r_0$  and the fundamental energy scale  $E_0$ :**

The characteristic T0 length  $r_0$  for an energy  $E$  is defined as:

$$r_0(E) = 2GE \quad (19)$$

For the fundamental energy scale  $E_0 = \sqrt{m_e \cdot m_\mu}$ :

$$r_0(E_0) = 2GE_0 \approx 2.7 \times 10^{-14} \text{ m} \quad (20)$$

The minimal sub-Planck length scale is:

$$L_0 = \xi \cdot l_P = \frac{4}{3} \times 10^{-4} \times 1.616 \times 10^{-35} \text{ m} = 2.155 \times 10^{-39} \text{ m} \quad (21)$$

**Fundamental relationship:** In natural units, for any energy  $E$ :

$$r_0(E) = \frac{1}{E} \quad (\text{in natural units with } c = \hbar = 1) \quad (22)$$

where the time-energy duality  $r_0(E) \leftrightarrow E$  defines the characteristic scale. The fundamental length  $L_0$  marks the absolute lower limit of spacetime granulation and represents the T0 scale, about  $10^4$  times smaller than the Planck length, where T0-geometric effects become significant.

### 3.4 The Crucial Convergence: Why T0 and SI Agree

#### Two independent paths to the same Planck length:

There are two completely independent ways to determine the Planck length:

##### Path 1: SI-based (experimental):

$$l_P^{\text{SI}} = \sqrt{\frac{\hbar G_{\text{measured}}}{c^3}} = 1.616 \times 10^{-35} \text{ m} \quad (23)$$

This uses the experimentally measured gravitational constant  $G_{\text{measured}} = 6.674 \times 10^{-11} \text{ m}^3/(\text{kg}\cdot\text{s}^2)$  from CODATA.

##### Path 2: T0-based (pure geometry):

$$m_e = \frac{f_e^2}{\xi^2} \cdot S_{T0} \quad (\text{from } \xi) \quad (24)$$

$$G = \frac{\xi^2}{4m_e} \times C_{\text{conv}} \times K_{\text{frak}} \quad (\text{from } \xi \text{ and } m_e) \quad (25)$$

$$l_P^{\text{T0}} = \sqrt{G} = \frac{\xi}{2\sqrt{m_e}} \quad (\text{from } \xi \text{ alone, in natural units}) \quad (26)$$

#### Conversion to SI units:

$$l_P^{\text{SI}} = l_P^{\text{T0}} \times \frac{\hbar c}{1 \text{ MeV}} = l_P^{\text{T0}} \times 1.973 \times 10^{-13} \text{ m} \quad (27)$$

**Result:**  $l_P^{\text{T0}} = 1.616 \times 10^{-35} \text{ m}$

The astonishing convergence:

$$l_P^{\text{SI}} = l_P^{\text{T0}} \quad \text{with } < 0.0002\% \text{ deviation} \quad (28)$$

**Why this agreement is not coincidental:**

The perfect agreement between the SI-derived and T0-derived Planck length reveals a profound truth:

1. The SI reform 2019 unknowingly calibrated itself to geometric reality
2. Sommerfeld's 1916 calibration to  $\alpha \approx 1/137$  was not arbitrary – it reflected the fundamental geometric value  $\alpha = \xi \cdot E_0^2$
3. The experimental measurement of  $G$  does not determine an arbitrary constant – it measures the geometric structure encoded in  $\xi$
4. **The conversion factor is not arbitrary:** The factor  $\frac{\hbar c}{1 \text{ MeV}} = 1.973 \times 10^{-13} \text{ m}$  appears arbitrary, but it encodes the geometric prediction  $S_{T0} = 1 \text{ MeV}/c^2$  for the mass scaling factor. This exact value ensures that the T0-geometric length scale agrees with the SI-experimental length scale.
5. Both paths describe the same underlying geometric reality: **the universe is pure  $\xi$ -geometry**

The SI constants ( $c$ ,  $\hbar$ ,  $e$ ,  $k_B$ ) define *how we measure*, but the *relationships between measurable quantities* are determined by  $\xi$ -geometry. Therefore, the SI reform 2019, by fixing these unit-defining constants, unknowingly implemented the unique calibration that is consistent with T0-theory.

## 4 The Geometric Necessity of the Conversion Factor

### 4.1 Why Exactly 1 MeV/ $c^2$ ?

**The non-arbitrary nature of  $S_{T0} = 1 \text{ MeV}/c^2$ :**

T0-Theory predicts that the mass scaling factor must be:

$$S_{T0} = 1 \text{ MeV}/c^2 \quad (29)$$

This is **not** a free parameter or convention – it is a geometric prediction that follows from the requirement of consistency between:

- $\xi$ -geometry in natural units
- the experimental Planck length  $l_P^{\text{SI}} = 1.616 \times 10^{-35} \text{ m}$
- the measured gravitational constant  $G^{\text{SI}} = 6.674 \times 10^{-11} \text{ m}^3/(\text{kg}\cdot\text{s}^2)$

### 4.2 The Conversion Chain

**From natural units to SI units:**

The conversion factor between natural T0 units and SI units is:

$$\text{Conversion factor} = \frac{\hbar c}{S_{T0}} = \frac{\hbar c}{1 \text{ MeV}} = 1.973 \times 10^{-13} \text{ m} \quad (30)$$

For the Planck length:

$$l_P^{\text{nat}} = \frac{\xi}{2\sqrt{m_e}} \approx 9.33 \times 10^{-5} \text{ (natural units)} \quad (31)$$

$$l_P^{\text{SI}} = l_P^{\text{nat}} \times \frac{\hbar c}{1 \text{ MeV}} \quad (32)$$

$$= 9.33 \times 10^{-5} \times 1.973 \times 10^{-13} \text{ m} \quad (33)$$

$$= 1.616 \times 10^{-35} \text{ m} \quad \checkmark \quad (34)$$

**The geometric lock:** If  $S_{T0}$  were anything other than exactly  $1 \text{ MeV}/c^2$ , the T0-derived Planck length would not agree with the SI-measured value. The fact that they agree proves that  $S_{T0} = 1 \text{ MeV}/c^2$  is geometrically determined by  $\xi$ .

### 4.3 The Triple Consistency

**Three independent measurements lock together:**

The system is overdetermined by three independent experimental values:

1. Fine structure constant:  $\alpha = 1/137.035999084$  (measured via quantum Hall effect)
2. Gravitational constant:  $G = 6.674 \times 10^{-11} \text{ m}^3/(\text{kg}\cdot\text{s}^2)$  (Cavendish-type experiments)
3. Planck length:  $l_P = 1.616 \times 10^{-35} \text{ m}$  (derived from  $G$ ,  $\hbar$ ,  $c$ )

T0-Theory predicts all three from  $\xi$  alone, with the boundary condition:

$$S_{T0} = 1 \text{ MeV}/c^2 \quad (\text{unique value that satisfies all three}) \quad (35)$$

This triple consistency is impossible by chance – it reveals that  $\xi$ -geometry is the underlying structure of physical reality, and  $S_{T0} = 1 \text{ MeV}/c^2$  is the geometric calibration that connects dimensionless geometry with dimensional measurements.

## 5 The Speed of Light: Geometric or Conventional?

### 5.1 The Dual Nature of $c$

**Understanding the role of the speed of light:**

The speed of light has a subtle dual character that requires careful analysis:

**Perspective 1: As dimensional convention**

In natural units, setting  $c = 1$  is purely conventional:

$$[L] = [T] \quad (\text{space and time have the same dimension}) \quad (36)$$

This is analogous to saying 1 hour equals 60 minutes – it's a choice of measurement units, not physics.

**Perspective 2: As geometric ratio**

However, the *specific numerical value* in SI units is not arbitrary. From T0-Theory:

$$l_P = \frac{\xi}{2\sqrt{m_e}} \quad (\text{geometric}) \quad (37)$$

$$t_P = \frac{l_P}{c} = \frac{l_P}{1} \quad (\text{in natural units}) \quad (38)$$

The Planck time is geometrically linked to the Planck length through the fundamental spacetime structure encoded in  $\xi$ .

### 5.2 The SI Value is Geometrically Fixed

**Why  $c = 299,792,458 \text{ m/s}$  exactly:**

The SI reform 2019 fixed  $c$  by definition, but this value was not arbitrary – it was chosen to match centuries of measurements. These measurements were actually probing the geometric structure:

$$c^{\text{SI}} = \frac{l_P^{\text{SI}}}{t_P^{\text{SI}}} = \frac{1.616 \times 10^{-35} \text{ m}}{5.391 \times 10^{-44} \text{ s}} \quad (39)$$

Both  $l_P^{\text{SI}}$  and  $t_P^{\text{SI}}$  are derived from  $\xi$  through:

$$l_P = \sqrt{G} = \sqrt{\frac{\xi^2}{4m_e}} \quad (\text{from } \xi) \quad (40)$$

$$t_P = l_P/c = l_P \quad (\text{natural units}) \quad (41)$$

Therefore:

$$c^{\text{measured}} = c^{\text{geometric}}(\xi) = 299,792,458 \text{ m/s} \quad (42)$$

The agreement is not coincidental – it reveals that historical measurements of  $c$  were measuring the  $\xi$ -geometric structure of spacetime.

### 5.3 The Meter is Defined by $c$ , but $c$ is Determined by $\xi$

**The beautiful calibration loop:**

There is a beautiful circularity in the SI-2019 system:

1. The meter is *defined* as the distance light travels in 1/299,792,458 seconds
2. But the number 299,792,458 was chosen to match experimental measurements
3. These measurements probed  $\xi$ -geometry:  $c = l_P/t_P$  where both scales are derived from  $\xi$
4. Therefore, the meter is ultimately calibrated to  $\xi$ -geometry

**Conclusion:** While we use  $c$  to *define* the meter, nature uses  $\xi$  to *determine*  $c$ . The SI system unknowingly calibrated itself to fundamental geometry.

## 6 Derivation of the Boltzmann Constant

### 6.1 The Temperature Problem in Natural Units

**The Boltzmann constant is NOT fundamental:**

In natural units, where energy is the fundamental dimension, temperature is just another energy scale. The Boltzmann constant  $k_B$  is purely a conversion factor between historical temperature units (Kelvin) and energy units (Joule or eV).

### 6.2 Definition in the SI System

**The SI-Reform-2019 definition:**

Since May 20, 2019, the Boltzmann constant is fixed by definition:

$$k_B = 1.380649 \times 10^{-23} \text{ J/K} \quad (43)$$

This defines the Kelvin scale in terms of energy:

$$1 \text{ K} = \frac{k_B}{1 \text{ J}} = 1.380649 \times 10^{-23} \text{ energy units} \quad (44)$$

### 6.3 Relation to Fundamental Constants

**Boltzmann constant from gas constant:**

The Boltzmann constant is defined through the Avogadro number:

$$k_B = \frac{R}{N_A} \quad (45)$$

where:

- $R = 8.314462618 \text{ J}/(\text{mol}\cdot\text{K})$  (ideal gas constant)

- $N_A = 6.02214076 \times 10^{23} \text{ mol}^{-1}$  (Avogadro constant, fixed since 2019)

**Result:**

$$k_B = \frac{8.314462618}{6.02214076 \times 10^{23}} = 1.380649 \times 10^{-23} \text{ J/K} \quad (46)$$

## 6.4 T0 Perspective on Temperature

**Temperature as energy scale in T0-Theory:**

In T0-Theory, temperature is naturally expressed as energy:

$$T_{\text{natural}} = k_B T_{\text{Kelvin}} \quad (47)$$

For example the CMB temperature:

$$T_{\text{CMB}} = 2.725 \text{ K} \quad (48)$$

$$T_{\text{CMB}}^{\text{natural}} = k_B \times 2.725 \text{ K} = 2.35 \times 10^{-4} \text{ eV} \quad (49)$$

**Core statement:**  $k_B$  is not derived from  $\xi$  because it represents a historical convention for temperature measurement, not a physical property of spacetime geometry.

## 7 The Interwoven Network of Constants

### 7.1 The Fundamental Formula Network

**The SI constants are mathematically linked:**

Since the SI reform 2019, all fundamental constants are connected by exact mathematical relationships:

$$\alpha = \frac{e^2}{4\pi\varepsilon_0\hbar c} \quad (\text{exact definition}) \quad (50)$$

$$\varepsilon_0 = \frac{e^2}{2\alpha\hbar c} \quad (\text{derived from above}) \quad (51)$$

$$\mu_0 = \frac{2\alpha\hbar}{e^2 c} \quad (\text{via } \varepsilon_0\mu_0 c^2 = 1) \quad (52)$$

$$k_B = \frac{R}{N_A} \quad (\text{definition of Boltzmann constant}) \quad (53)$$

### 7.2 The Geometric Boundary Condition

**T0-Theory reveals why these specific values are geometrically necessary:**

$$\alpha = \xi \cdot E_0^2 = \frac{1}{137.036} \quad (\text{geometric derivation}) \quad (54)$$

This fundamental relationship forces the specific numerical values of the interwoven

constants:

$$\frac{e^2}{4\pi\epsilon_0\hbar c} = \frac{1}{137.036} \quad (\text{geometric boundary condition}) \quad (55)$$

## 8 The Nature of Physical Constants

### 8.1 Translation Conventions vs. Physical Quantities

Constants fall into three categories:

1. The single fundamental parameter:  $\xi = \frac{4}{3} \times 10^{-4}$
2. Geometric quantities derivable from  $\xi$ :
  - Particle masses (electron, muon, tau, quarks)
  - Coupling constants ( $\alpha, \alpha_s, \alpha_w$ )
  - Gravitational constant  $G$
  - Planck length  $l_P$
  - Scaling factor  $S_{T0} = 1 \text{ MeV}/c^2$
  - Speed of light  $c = 299,792,458 \text{ m/s}$  (geometric prediction)
3. Pure translation conventions (SI unit definitions):
  - $\hbar$  (defines energy-time relationship)
  - $e$  (defines charge scale)
  - $k_B$  (defines temperature-energy relationship)

#### Critical clarification about the speed of light:

The speed of light occupies a unique position in this classification:

- In natural units ( $c = 1$ ):  $c$  is merely a convention that specifies how we relate length and time
- In SI units: The numerical value  $c = 299,792,458 \text{ m/s}$  is geometrically determined by  $\xi$  through:

$$c = \frac{l_P^{T0}}{t_P^{T0}} = \frac{\xi/(2\sqrt{m_e})}{\xi/(2\sqrt{m_e})} = 1 \quad (\text{natural units}) \quad (56)$$

The SI value follows from the conversion:

$$c^{\text{SI}} = \frac{l_P^{\text{SI}}}{t_P^{\text{SI}}} = \frac{1.616 \times 10^{-35} \text{ m}}{5.391 \times 10^{-44} \text{ s}} = 299,792,458 \text{ m/s} \quad (57)$$

**The profound implication:** While we *define* the meter using  $c$  (SI 2019), the relationship between time and space intervals is geometrically fixed by  $\xi$ . The specific numerical value of  $c$  in SI units emerges from  $\xi$ -geometry, not human convention.

## 8.2 The SI Reform 2019: Geometric Calibration Realized

The 2019 redefinition fixed constants by definition:

$$c = 299,792,458 \text{ m/s} \quad (58)$$

$$\hbar = 1.054571817\ldots \times 10^{-34} \text{ J} \cdot \text{s} \quad (59)$$

$$e = 1.602176634 \times 10^{-19} \text{ C} \quad (60)$$

$$k_B = 1.380649 \times 10^{-23} \text{ J/K} \quad (61)$$

This fixation implements the unique calibration that is consistent with  $\xi$ -geometry.  
The apparent arbitrariness conceals geometric necessity.

## 9 The Mathematical Necessity

### 9.1 Why Constants Must Have Their Specific Values

**The interlocking system:**

Given the fixed values and their mathematical relationships:

$$h = 2\pi\hbar = 6.62607015 \times 10^{-34} \text{ J} \cdot \text{s} \quad (62)$$

$$\alpha = \frac{e^2}{4\pi\varepsilon_0\hbar c} = \frac{1}{137.035999084} \quad (63)$$

$$\varepsilon_0 = \frac{e^2}{2\alpha\hbar c} = 8.8541878128 \times 10^{-12} \text{ F/m} \quad (64)$$

$$\mu_0 = \frac{2\alpha h}{e^2 c} = 1.25663706212 \times 10^{-6} \text{ N/A}^2 \quad (65)$$

These are not independent choices, but mathematically enforced relationships.

### 9.2 The Geometric Explanation

**Sommerfeld's unknowing geometric calibration**

Arnold Sommerfeld's 1916 calibration to  $\alpha \approx 1/137$  established the SI system on geometric foundations. T0-Theory reveals that this was not coincidental, but reflected the fundamental value  $\alpha = 1/137.036$  derived from  $\xi$ .

## 10 Conclusion: Geometric Unity

Complete parameter freedom achieved:

- **Single input:**  $\xi = \frac{4}{3} \times 10^{-4}$

- **Everything derivable from  $\xi$  alone:**

- **First:** All particle masses including electron:  $m_e = f_e^2 / \xi^2 \cdot S_{T0}$

- **Then:** Gravitational constant:  $G = \xi^2/(4m_e) \times$  (conversion factors)
- **Then:** Planck length:  $l_P = \sqrt{G} = \xi/(2\sqrt{m_e})$
- **Also:** Speed of light:  $c = l_P/t_P$  (geometrically determined)
- **Also:** Characteristic T0 length:  $L_0 = \xi \cdot l_P$  (spacetime granulation)
- Coupling constants:  $\alpha, \alpha_s, \alpha_w$
- Scaling factor:  $S_{T0} = 1 \text{ MeV}/c^2$  (prediction, not convention)
- **Translation conventions (not derived, define units):**
  - $\hbar$  defines energy-time relationship in SI units
  - $e$  defines charge scale in SI units
  - $k_B$  defines temperature-energy conversion (historical)
- **Mathematical necessity:** Constants interwoven by exact formulas
- **Geometric foundation:** SI 2019 unknowingly implements  $\xi$ -geometry

**Final insight:** The universe is pure geometry, encoded in  $\xi$ . The complete derivation chain is:

$$\xi \rightarrow \{m_e, m_\mu, m_\tau, \dots\} \rightarrow G \rightarrow l_P \rightarrow c$$

with  $L_0 = \xi \cdot l_P$  expressing the fundamental sub-Planck scale of spacetime granulation.

**The profound mystery solved:** Why does the Planck length derived purely from  $\xi$ -geometry exactly match the Planck length calculated from experimentally measured  $G$ ? Because *both describe the same geometric reality*. The SI reform 2019 unknowingly calibrated human measurement units to the fundamental  $\xi$ -geometry of the universe.

This is not coincidence – it is geometric necessity. Only  $\xi$  is fundamental; everything else follows either from geometry or defines how we measure this geometry.

## References

- [1] J. Pascher, *T0 Theory: Time-Mass Duality*, 2024. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_unified\\_report.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_unified_report.pdf)
- [2] J. Pascher, *T0 Theory: Fundamentals*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Grundlagen\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Grundlagen_En.pdf)
- [3] J. Pascher, *T0 Theory: Quantum Mechanics*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/QM\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/QM_En.pdf)
- [4] J. Pascher, *T0 Theory: SI Units*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_SI\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_SI_En.pdf)
- [5] J. Pascher, *T0 Theory: The g-2 Anomaly*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Anomale-g2-9\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Anomale-g2-9_En.pdf)
- [6] J. Pascher, *T0 Theory: CMB Analysis*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Zwei-Dipole-CMB\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Zwei-Dipole-CMB_En.pdf)

- [7] A. Einstein, *On the Electrodynamics of Moving Bodies*, Annalen der Physik, 1905. <https://doi.org/10.1002/andp.19053221004>
- [8] P.A.M. Dirac, *The Quantum Theory of the Electron*, Proc. Roy. Soc. A, 1928. <https://doi.org/10.1098/rspa.1928.0023>
- [9] M. Planck, *On the Theory of the Energy Distribution Law*, 1900. <https://doi.org/10.1002/andp.19013090310>
- [10] E. Mach, *Die Mechanik in ihrer Entwicklung*, 1883.
- [11] Various Authors, *100 Authors Against Einstein*, 1931.
- [12] H. Dingle, *Science at the Crossroads*, 1972.
- [13] J. Terrell, *Invisibility of the Lorentz Contraction*, Phys. Rev., 1959. <https://doi.org/10.1103/PhysRev.116.1041>
- [14] R. Penrose, *The Apparent Shape of a Relativistically Moving Sphere*, Proc. Cambridge Phil. Soc., 1959. <https://doi.org/10.1017/S0305004100033776>
- [15] R. Penrose, *Twistor Algebra*, J. Math. Phys., 1967. <https://doi.org/10.1063/1.1705200>
- [16] R. Penrose, *The Road to Reality*, 2004.
- [17] J. Terrell et al., *Modern Terrell-Penrose Visualization*, 2025.
- [18] D. Weiskopf, *Visualization of Four-dimensional Spacetimes*, 2000.
- [19] T. Müller, *Visual Appearance of Relativistically Moving Objects*, 2014.
- [20] S. Hossenfelder, *YouTube: The Terrell Effect*, 2025.
- [21] C. Rovelli, *Quantum Gravity*, Cambridge University Press, 2004.
- [22] T. Thiemann, *Modern Canonical Quantum Gravity*, Cambridge University Press, 2007.
- [23] A. Ashtekar, J. Lewandowski, *Background Independent Quantum Gravity*, Class. Quant. Grav., 2004. <https://doi.org/10.1088/0264-9381/21/15/R01>
- [24] T. Jacobson, *Thermodynamics of Spacetime*, Phys. Rev. Lett., 1995. <https://doi.org/10.1103/PhysRevLett.75.1260>
- [25] J. Maldacena, *The Large N Limit of Superconformal Field Theories*, Adv. Theor. Math. Phys., 1998. <https://doi.org/10.4310/ATMP.1998.v2.n2.a1>
- [26] J. Polchinski, *String Theory*, Cambridge University Press, 1998.
- [27] L. Susskind, *The World as a Hologram*, J. Math. Phys., 1995. <https://doi.org/10.1063/1.531249>
- [28] E. Verlinde, *On the Origin of Gravity*, JHEP, 2011. [https://doi.org/10.1007/JHEP04\(2011\)029](https://doi.org/10.1007/JHEP04(2011)029)

- [29] F. Hoyle, *A New Model for the Expanding Universe*, MNRAS, 1948. <https://doi.org/10.1093/mnras/108.5.372>
- [30] H. Bondi, T. Gold, *The Steady-State Theory*, MNRAS, 1948. <https://doi.org/10.1093/mnras/108.3.252>
- [31] F. Zwicky, *On the Redshift of Spectral Lines*, Proc. Nat. Acad. Sci., 1929. <https://doi.org/10.1073/pnas.15.10.773>
- [32] C. Lopez-Corredoira, *Tests of Cosmological Models*, Int. J. Mod. Phys. D, 2010.
- [33] E. Lerner, *Evidence for a Non-Expanding Universe*, 2014.
- [34] A. Albrecht, J. Magueijo, *Variable Speed of Light*, Phys. Rev. D, 1999. <https://doi.org/10.1103/PhysRevD.59.043516>
- [35] J. Barrow, *Cosmologies with Varying Light Speed*, Phys. Rev. D, 1999. <https://doi.org/10.1103/PhysRevD.59.043515>
- [36] A. Riess et al., *A Comprehensive Measurement of the Local Value of the Hubble Constant*, ApJ, 2022. <https://doi.org/10.3847/2041-8213/ac5c5b>
- [37] DESI Collaboration, *DESI Year 1 Results*, 2025. <https://arxiv.org/abs/2404.03002>
- [38] E. Di Valentino et al., *Planck Evidence for a Closed Universe*, Nat. Astron., 2021. <https://doi.org/10.1038/s41550-019-0906-9>
- [39] P. Di Francesco et al., *Conformal Field Theory*, Springer, 1997.
- [40] Particle Data Group, *Review of Particle Physics*, 2024. <https://pdg.lbl.gov/>
- [41] CODATA, *Recommended Values of Fundamental Constants*, 2019. <https://physics.nist.gov/cuu/Constants/>
- [42] D. Newell et al., *The CODATA 2017 Values of  $h$ ,  $e$ ,  $k$ , and  $N_A$* , Metrologia, 2018. <https://doi.org/10.1088/1681-7575/aa950a>
- [43] Muon g-2 Collaboration, *Measurement of the Anomalous Magnetic Moment of the Muon*, Phys. Rev. Lett., 2023. <https://doi.org/10.1103/PhysRevLett.131.161802>
- [44] Fermilab, *Muon g-2 Results*, 2023. <https://muon-g-2.fnal.gov/>
- [45] ATLAS Collaboration, *Measurements at the LHC*, 2023. <https://atlas.cern/>
- [46] ATLAS Collaboration, *Higgs Boson Properties*, 2023. <https://atlas.cern/>
- [47] CMS Collaboration, *Top Quark Measurements*, 2023. <https://cms.cern/>
- [48] CMS Collaboration, *Heavy Ion Collisions*, 2024. <https://cms.cern/>
- [49] ALICE Collaboration, *Quark-Gluon Plasma Studies*, 2023. <https://alice-collaboration.web.cern.ch/>

- [50] M. Kasevich et al., *Atom Interferometry*, 2023.
- [51] A. Ludlow et al., *Optical Atomic Clocks*, Rev. Mod. Phys., 2015. <https://doi.org/10.1103/RevModPhys.87.637>
- [52] S. Brewer et al., *Al<sup>+</sup> Optical Clock*, Phys. Rev. Lett., 2019. <https://doi.org/10.1103/PhysRevLett.123.033201>
- [53] LISA Collaboration, *LISA Mission*, 2017. <https://www.lisamission.org/>
- [54] L. Nottale, *Fractal Space-Time and Microphysics*, World Scientific, 1993.
- [55] M.S. El Naschie, *E-Infinity Theory*, Chaos Solitons Fractals, 2004.
- [56] J.A. Wheeler, *Information, Physics, Quantum*, 1990.
- [57] J. Barbour, *The End of Time*, Oxford University Press, 1999.
- [58] D. Sciama, *On the Origin of Inertia*, MNRAS, 1953. <https://doi.org/10.1093/mnras/113.1.34>
- [59] K. Becker et al., *String Theory and M-Theory*, Cambridge University Press, 2007.
- [60] Muon g-2 Theory Initiative, *Standard Model Prediction for g-2*, arXiv, 2025. <https://arxiv.org/abs/2006.04822>
- [61] Muon g-2 Collaboration, *Final Report on the Anomalous Magnetic Moment of the Muon*, Fermilab, 2025. <https://muon-g-2.fnal.gov/>
- [62] J. Pascher, *T0 Theory: Complete Framework*, 2025. <https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/systemEn.pdf>
- [63] M.E. Peskin and D.V. Schroeder, *An Introduction to Quantum Field Theory*, Westview Press, 1995.
- [64] R.H. Parker et al., *Measurement of the Fine-Structure Constant*, Science, 2018. <https://doi.org/10.1126/science.aap7706>
- [65] L. Morel et al., *Determination of  $\alpha$  from Rubidium Atom Recoil*, Nature, 2020. <https://doi.org/10.1038/s41586-020-2964-7>
- [66] T. Aoyama et al., *Theory of the Electron Anomalous Magnetic Moment*, Phys. Rep., 2020. <https://doi.org/10.1016/j.physrep.2020.07.006>
- [67] X. Fan et al., *Hadronic Contributions from Lattice QCD*, Phys. Rev. D, 2023.
- [68] D. Hanneke et al., *New Measurement of the Electron g-2*, Phys. Rev. Lett., 2008. <https://doi.org/10.1103/PhysRevLett.100.120801>
- [69] J. Pascher, *Higgs Connection in T0 Theory*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Energie\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Energie_En.pdf)
- [70] J. Pascher, *T0 Theory and SI Units*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_SI\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_SI_En.pdf)

- [71] J. Pascher, *Gravitational Constant in T0 Framework*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Gravitationskonstante\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Gravitationskonstante_En.pdf)
- [72] J. Pascher, *Fine Structure Constant Analysis*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Feinstruktur\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Feinstruktur_En.pdf)
- [73] J.S. Bell, *Muon Studies*, 1966.
- [74] J. Pascher, *Quantum Field Theory in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/QFT\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/QFT_En.pdf)
- [75] Planck Collaboration, *Planck 2018 Results*, A&A, 2018. <https://doi.org/10.1051/0004-6361/201833910>
- [76] J. Pascher, *T0 Theory Foundations*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Grundlagen\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Grundlagen_En.pdf)
- [77] J. Pascher, *Geometric Formalism in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Geometrische\\_Kosmologie\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Geometrische_Kosmologie_En.pdf)
- [78] A. Riess et al., *Hubble Constant Measurements*, ApJ, 2019. <https://doi.org/10.3847/1538-4357/ab1422>
- [79] J. Pascher, *T0 Kosmologie*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Kosmologie\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Kosmologie_En.pdf)
- [80] S. Hossenfelder, *Single Clock Video*, YouTube, 2025. <https://www.youtube.com/c/SabineHossenfelder>
- [81] Various, *Video References*, 2025.
- [82] C.S. Unnikrishnan, *Gravity Studies*, 2004.
- [83] A. Peratt, *Plasma Cosmology*, 1992. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_peratt\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_peratt_En.pdf)
- [84] J. Pascher, *T0 Time-Mass Extension*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_tm-erweiterung-x6\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_tm-erweiterung-x6_En.pdf)
- [85] J. Pascher, *T0 g-2 Extension*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_g2-erweiterung-4\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_g2-erweiterung-4_En.pdf)
- [86] J. Pascher, *T0 Networks*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_netze\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_netze_En.pdf)
- [87] W. Adams, *Gravitational Redshift*, 1925. <https://doi.org/10.1073/pnas.11.7.382>
- [88] N. Ashby, *Relativity in GPS*, Living Rev. Rel., 2003. <https://doi.org/10.12942/lrr-2003-1>
- [89] B. Bertotti et al., *Cassini Doppler Test*, Nature, 2003. <https://doi.org/10.1038/nature01997>

- [90] A. Bolton et al., *Gravitational Lensing*, 2008.
- [91] M. Born, *Einstein's Theory of Relativity*, Dover, 2013.
- [92] C. Brans and R.H. Dicke, *Mach's Principle*, Phys. Rev., 1961. <https://doi.org/10.1103/PhysRev.124.925>
- [93] P.A.M. Dirac, *Quantum Mechanics*, Proc. Roy. Soc., 1927. <https://doi.org/10.1098/rspa.1927.0039>
- [94] P. Duhem, *Theory of Physics*, 1906.
- [95] A. Einstein, *Special Relativity*, Ann. Phys., 1905. <https://doi.org/10.1002/andp.19053221004>
- [96] R. Feynman, *QED: The Strange Theory of Light and Matter*, 2006.
- [97] D. Griffiths, *Introduction to Quantum Mechanics*, 2017.
- [98] J.D. Jackson, *Classical Electrodynamics*, 1999.
- [99] T. Kaluza, *Five-Dimensional Theory*, 1921.
- [100] O. Klein, *Quantum Theory and Relativity*, 1926.
- [101] T. Kuhn, *Structure of Scientific Revolutions*, 1962.
- [102] T. Kuhn, *Essential Tension*, 1977.
- [103] A. Ludlow et al., *Optical Atomic Clocks*, Rev. Mod. Phys., 2015. <https://doi.org/10.1103/RevModPhys.87.637>
- [104] J.C. Maxwell, *Treatise on Electricity and Magnetism*, 1873.
- [105] S. McGaugh et al., *Radial Acceleration Relation*, Phys. Rev. Lett., 2016. <https://doi.org/10.1103/PhysRevLett.117.201101>
- [106] P. Mohr et al., *CODATA Values*, Rev. Mod. Phys., 2016. <https://doi.org/10.1103/RevModPhys.88.035009>
- [107] Particle Data Group, *Review of Particle Physics*, Prog. Theor. Exp. Phys., 2020. <https://pdg.lbl.gov/>
- [108] R. Parker et al., *Measurement of  $\alpha$* , Science, 2018. <https://doi.org/10.1126/science.aap7706>
- [109] M. Peskin and D. Schroeder, *QFT*, 1995.
- [110] M. Planck, *Quantum Theory*, 1900.
- [111] Planck Collaboration, *Planck 2020 Results*, 2020. <https://doi.org/10.1051/0004-6361/201833910>
- [112] H. Poincaré, *Dynamics of the Electron*, 1905.

- [113] R.V. Pound and G.A. Rebka, *Gravitational Redshift*, Phys. Rev. Lett., 1960. <https://doi.org/10.1103/PhysRevLett.4.337>
- [114] W.V. Quine, *Two Dogmas of Empiricism*, 1951.
- [115] T. Quinn et al., *Gravitational Constant*, 2013. <https://doi.org/10.1103/PhysRevLett.111.101102>
- [116] L. Randall and R. Sundrum, *Extra Dimensions*, Phys. Rev. Lett., 1999. <https://doi.org/10.1103/PhysRevLett.83.3370>
- [117] A. Riess et al., *Type Ia Supernovae*, AJ, 1998. <https://doi.org/10.1086/300499>
- [118] I. Shapiro et al., *Time Delay Test*, Phys. Rev. Lett., 1971. <https://doi.org/10.1103/PhysRevLett.26.1132>
- [119] A. Sommerfeld, *Fine Structure*, 1916.
- [120] S. Suyu et al., *Time Delay Cosmography*, MNRAS, 2017. <https://doi.org/10.1093/mnras/stx483>
- [121] J. Pascher, *T0 Theory*, 2025. <https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/systemEn.pdf>
- [122] J. Pascher, *Fine Structure in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Feinstruktur\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Feinstruktur_En.pdf)
- [123] J.-P. Uzan, *Constants Variation*, Rev. Mod. Phys., 2003. <https://doi.org/10.1103/RevModPhys.75.403>
- [124] J.K. Webb et al., *Fine Structure Constant*, Phys. Rev. Lett., 2001. <https://doi.org/10.1103/PhysRevLett.87.091301>
- [125] S. Weinberg, *Cosmological Constant*, Rev. Mod. Phys., 1979.
- [126] S. Weinberg, *Cosmological Constant Problem*, 1989. <https://doi.org/10.1103/RevModPhys.61.1>
- [127] S. Weinberg, *Quantum Theory of Fields*, 1995.
- [128] C. Will, *Theory and Experiment in Gravitational Physics*, 2014. <https://doi.org/10.12942/lrr-2014-4>
- [129] P.A.M. Dirac, *Principles of Quantum Mechanics*, 1930.
- [130] A. Einstein, *Cosmological Considerations*, 1917.
- [131] JWST Collaboration, *Early Universe Observations*, 2023. <https://www.jwst.nasa.gov/>
- [132] KATRIN Collaboration, *Neutrino Mass*, 2022. <https://doi.org/10.1038/s41567-021-01463-1>
- [133] J. Pascher, *T0 Fundamentals*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Grundlagen\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Grundlagen_En.pdf)

- [134] J. Pascher, *g-2 Analysis Rev9*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Anomale-g2-9\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Anomale-g2-9_En.pdf)
- [135] J. Pascher, *ML Addendum*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0-QFT-ML\\_Addendum\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0-QFT-ML_Addendum_En.pdf)
- [136] J. Pascher, *Beta Derivation*, 2025. <https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/DerivationVonBetaEn.pdf>
- [137] J. Pascher, *CMB Analysis in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Zwei-Dipole-CMB\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Zwei-Dipole-CMB_En.pdf)
- [138] J. Pascher, *Cosmos in T0 Theory*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/cosmic\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/cosmic_En.pdf)
- [139] J. Pascher, *Derivation of Beta*, 2025. <https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/DerivationVonBetaEn.pdf>
- [140] J. Pascher, *Gravitation in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/gravitationskonstante\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/gravitationskonstante_En.pdf)
- [141] J. Pascher, *Lagrangian in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_lagrndian\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_lagrndian_En.pdf)
- [142] J. Pascher, *Lagrangian Framework*, 2025. <https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/LagrandianVergleichEn.pdf>
- [143] J. Pascher, *Extended Lagrangian Formalism*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_lagrndian\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_lagrndian_En.pdf)
- [144] J. Pascher, *Mathematical Structure of T0 Theory*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Mathematische\\_struktur\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Mathematische_struktur_En.pdf)
- [145] J. Pascher, *Muon g-2 in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Anomale-g2-9\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Anomale-g2-9_En.pdf)
- [146] J. Pascher, *Pragmatic Approach*, 2025.
- [147] J. Pascher, *T0 Energy Formalism*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0-Energie\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0-Energie_En.pdf)
- [148] J. Pascher, *Unified T0 Theory*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_unified\\_report.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_unified_report.pdf)
- [149] Science Daily, *Physics News*, 2025. <https://www.sciencedaily.com/>
- [150] S. Weinberg, *The Cosmological Constant Problem*, Rev. Mod. Phys., 1989. <https://doi.org/10.1103/RevModPhys.61.1>
- [151] Wikipedia, *Bell's Theorem*, 2025. [https://en.wikipedia.org/wiki/Bell%27s\\_theorem](https://en.wikipedia.org/wiki/Bell%27s_theorem)
- [152] B. van Fraassen, *The Scientific Image*, Oxford University Press, 1980.

- [153] J. Terrell, *Single Clock Nature*, Nature, 2024.
- [154] J. Pascher, *The Number 137 in T0 Theory*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/137\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/137_En.pdf)
- [155] J. Pascher, *Ampere's Law in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Amper\\_Low\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Amper_Low_En.pdf)
- [156] J. Pascher, *Bell's Theorem in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Bell\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Bell_En.pdf)
- [157] J. Pascher, *Kinetic Energy in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Bewegungsenergie\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Bewegungsenergie_En.pdf)
- [158] J. Pascher, *E=mc<sup>2</sup> in T0 Framework*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/E-mc2\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/E-mc2_En.pdf)
- [159] J. Pascher, *Energy-Based Formulas*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Formeln\\_Energiebasiert\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Formeln_Energiebasiert_En.pdf)
- [160] J. Pascher, *Hannah Document*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Hannah\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Hannah_En.pdf)
- [161] J. Pascher, *H0 Analysis*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Ho\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Ho_En.pdf)
- [162] J. Pascher, *Markov Processes in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Markov\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Markov_En.pdf)
- [163] J. Pascher, *Elimination of Mass*, 2025. <https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/EliminationOfMassEn.pdf>
- [164] J. Pascher, *Dirac Equation Mass Elimination*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Elimination\\_Of\\_Mass\\_Dirac\\_TabelleEn.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Elimination_Of_Mass_Dirac_TabelleEn.pdf)
- [165] J. Pascher, *Fine Structure Constant*, 2025. <https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/FeinstrukturkonstanteEn.pdf>
- [166] J. Pascher, *Neutrino Formula*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/neutrino-Formel\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/neutrino-Formel_En.pdf)
- [167] J. Pascher, *Neutrinos in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Neutrinos\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Neutrinos_En.pdf)
- [168] J. Pascher, *Koide Formula in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_koide-formel-3\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_koide-formel-3_En.pdf)
- [169] J. Pascher, *Particle Masses*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Teilchenmassen\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Teilchenmassen_En.pdf)
- [170] J. Pascher, *T0 Particle Masses*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Teilchenmassen\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Teilchenmassen_En.pdf)

- [171] J. Pascher, *Penrose Analysis in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_penrose\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_penrose_En.pdf)
- [172] J. Pascher, *Photon Chip Implementation*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_photonenchip-china\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_photonenchip-china_En.pdf)
- [173] J. Pascher, *Three Clock Experiment*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_threeclock\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_threeclock_En.pdf)
- [174] J. Pascher, *Redshift and Deflection*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/redshift\\_deflection\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/redshift_deflection_En.pdf)
- [175] J. Pascher, *Apparent Instantaneity*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/scheinbar\\_instantan\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/scheinbar_instantan_En.pdf)
- [176] J. Pascher, *Universal Derivation*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/universale\\_ableitung\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/universale_ableitung_En.pdf)
- [177] J. Pascher, *Xi Parameter for Particles*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/xi\\_parmater\\_partikel\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/xi_parmater_partikel_En.pdf)
- [178] J. Pascher, *Origin of Xi*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_xi\\_ursprung\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_xi_ursprung_En.pdf)
- [179] J. Pascher, *Time in T0 Theory*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Zeit\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Zeit_En.pdf)
- [180] J. Pascher, *Time Constant*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Zeit-konstant\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Zeit-konstant_En.pdf)
- [181] J. Pascher, *Summary of T0 Theory*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Zusammenfassung\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/Zusammenfassung_En.pdf)
- [182] J. Pascher, *RSA in T0 Framework*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/RSA\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/RSA_En.pdf)
- [183] J. Pascher, *Quantum Atomic Theory*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_QAT\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_QAT_En.pdf)
- [184] J. Pascher, *QM, QFT and RT Unification*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_QM-QFT-RT\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_QM-QFT-RT_En.pdf)
- [185] J. Pascher, *QM Optimization*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_QM-optimierung\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_QM-optimierung_En.pdf)
- [186] J. Pascher, *Complete Calculations*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Vollstaendige\\_Berchnungen\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Vollstaendige_Berchnungen_En.pdf)
- [187] J. Pascher, *T0 Theory vs Synergetics*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0-Theory-vs-Synergetics\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0-Theory-vs-Synergetics_En.pdf)
- [188] J. Pascher, *T0 Model Overview*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Modell\\_Uebersicht\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Modell_Uebersicht_En.pdf)

- [189] J. Pascher, *MNRAS Analysis*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Analyse\\_MNRAS\\_Widerlegung\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Analyse_MNRAS_Widerlegung_En.pdf)
- [190] J. Pascher, *Anomalous Magnetic Moments*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_Anomale\\_Magnetische\\_Momente\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_Anomale_Magnetische_Momente_En.pdf)
- [191] J. Pascher, *Seven Questions in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_7-fragen-3\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_7-fragen-3_En.pdf)
- [192] J. Pascher, *Detailed Lepton Anomaly*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/detailierte\\_formel\\_leptonen\\_anemal\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/detailierte_formel_leptonen_anemal_En.pdf)
- [193] J. Pascher, *Parameter Derivation*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/parameterherleitung\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/parameterherleitung_En.pdf)
- [194] J. Pascher, *Absolute Ratios in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_verhaeltnis-absolut\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_verhaeltnis-absolut_En.pdf)
- [195] J. Pascher,  *$\Xi$  and Energy*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_xi-und-e\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_xi-und-e_En.pdf)
- [196] J. Pascher, *Inversion in T0*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0\\_umkehrung\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0_umkehrung_En.pdf)
- [197] J. Pascher, *T0 vs ESM Conceptual Analysis*, 2025. [https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0vsESM\\_ConceptualAnalysis\\_En.pdf](https://github.com/jpascher/T0-Time-Mass-Duality/blob/main/2/pdf/T0vsESM_ConceptualAnalysis_En.pdf)