## Chapter 5: Tensor Traversal and the Structural Model of Temporal Progression

### Definition of Time

Time is not merely the manifestation of material change, but rather the expression of a directional will—a force that seeks to move forward. In this hypothesis, the universe is assumed to be structured by a tensor framework governed by directional energy distributions. This structure consists of six spatial directions ($x_1$ to $x_6$) and a temporal extension axis (t-axis). Movement along different axes results in differing quantities of tensor traversal, which in turn affects the progression of time.

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### Time = Will to Advance (Direction-Oriented Intent)

- The "flow of time" does not occur spontaneously; it is the result of a directional, space-structured force attempting to advance.
- In essence, the **nature of time** is defined as a vectorial propulsion of energy that operates in synchrony with the external structure of space—the tensor framework.

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### Tensor Traversal = Dissipation of Forward Momentum

- A greater number of tensor traversals indicates that energy interacts more frequently with spatial structures.
- This does not mean "time advances," but rather that the **force to advance is depleted**—attenuated through spatial interference.

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### Unified Equation Definitions

The relationship between tensor structure and temporal loss in this chapter is consistently represented by the following formulas:

$N = L \times \cos\theta \times k$

$\Delta t = \alpha \times N$

Alternatively, by incorporating the density constant into the coefficient, the relationship can be expressed as:

$\Delta t = \alpha \times L \times \cos\theta$

Furthermore, when altitude correction and attenuation structure are taken into account, the equation becomes:

$\Delta t = \tau \times e^{\wedge}(-\alpha \times L \times \cos(\theta) \times e^{\wedge}(-\beta h))$

Definition of Symbols and Units

**N**: Tensor passage count (number of intersections with the tensor structure in space) [dimensionless]

**$\Delta t$**: Time deviation or modulation [seconds]

**L**: Spatial travel distance or passage length [m]

**$\cos\theta$**: Cosine of the intersection angle between the observation vector and the tensor structure axis (alignment coefficient) [dimensionless]

**k**: Tensor density constant (amount of tensors per unit reference space) [1/m]

**$\alpha$**: Tensor loss coefficient (rate of temporal loss due to passage) [1/m]

**$\tau$**: Correction constant (empirical adjustment value; time scaling factor) [s]

**$\beta$**: Altitude attenuation coefficient (approximates atmospheric density or gravitational influence exponentially) [1/m]

**h**: Altitude of the observation point or target object [m]

**●Tensor-Direction-Based Loss Correction Model (T1 Reference)**

This document presents an absolute reference model for evaluating energy loss and temporal modulation across the six-directional tensor structure, using the **T1 axis** as the standard. The model accounts for the differences in tensor intersection point densities across each direction and accurately evaluates their influence on **exponential attenuation**.

**Relative Tensor Passage Density by Direction**

| Direction | Definition Vector | Relative Tensor Passage Density |
|---|---|---|
| x1 | (1, 0, 0) | 1.00 |
| x2 | (0, 1, 0) | 1.00 |
| x3 | (0, 0, 1) | 1.00 |
| x4 | (−1, 0, 0) | 1.00 |
| x5 | (0, −1, 0) | 1.00 |
| x6 | (0, 0, −1) | 1.00 |
| t1 | (1, 1, 1) | 0.577 |
| t2 | (−1, 1, 1) | 0.577 |
| t3 | (1, −1, 1) | 0.577 |
| t4 | (1, 1, −1) | 0.577 |

In this paper, the term *"density"* does not refer to the conventional physical notion of spatial concentration or accumulation of mass. Instead, it should be understood within the context of a uniform tensor structure assumed to exist throughout all regions of the universe.

The tensor structure of space, as proposed in this hypothesis, is considered to be homogeneous, with no inherent density variations. However, in describing certain phenomena, expressions such as *"high density"* or *"density concentration"* are used to indicate states in which the number of tensor passages becomes significantly large.
These expressions are metaphorical in nature and are intended to visually convey directional convergence or an increased number of tensor passages within the structural framework.
They do not imply any physical non-uniformity or fluctuation in the fabric of space itself.

## Section 1: Tensor Structure of Cosmic Space and the Basis of Time

It is hypothesized that cosmic space is governed by a tensor structure based on the directional organization of energy. This hypothesis posits the existence of six spatial directions ($x_1$ through $x_6$) and an extended temporal axis (t-axis). Movement or progression along each axis results in differing numbers of tensor passages, which in turn suggest variations in the progression of time.

### Distance-Based Time Loss Assumption

When a distance L (in meters) is traversed, the number of tensors passed through, N, varies depending on how the direction of motion intersects with the tensor structure, as represented by $\cos(\theta)$. The assumed equation is as follows:

$$N = L \times \cos(\theta) \times k$$

Where:

- N: Number of tensor passages
- L: Distance of movement [m]
- $\cos\theta$ ： Cosine of the angle between the direction of motion and the tensor structure axis (range: 0–1)
- k: Spatial tensor density constant (unit normalized)

In directions aligned with the t-axis (e.g., $t_1$), $\cos\theta \approx 0$, resulting in minimal tensor passage. Conversely, in directions aligned with the x-axis, $\cos\theta \approx 1$, producing the maximum number of tensor passages.

### Temporal Progression and Structural Differences in Space

This variation in tensor passage count directly influences the rate of temporal progression along different axes. Notably, while passage counts remain relatively uniform among various t-axes ($t_1$, $t_2$, etc.), there is a significant increase in tensor passage in x-axis directions. This increase corresponds to a greater degree of temporal retardation.

### Conclusion

The progression of time is dependent on the number of tensor structures traversed during spatial movement. Movement along the t-axis incurs minimal temporal loss, while movement along the x-axis results in maximal loss. This concept forms the foundational basis for the subsequent hypothesis on tensor-induced time modulation.

## Section 2: Re-evaluation of the Aircraft Atomic Clock Experiment

### Reinterpreting the Hafele–Keating Experiment Using Tensor-Passage Loss

### Objective

This section aims to reinterpret the time discrepancy observed in the well-known aircraft atomic clock experiment (Hafele–Keating, 1971) from the perspective of energy loss due to directional tensor structure passage. Based on a distance-based model, we derive and verify the loss coefficient $\alpha$.

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### Summary of the Original Experiment

- Two aircraft were flown in opposite directions: one eastward (in the direction of Earth's rotation), and the other westward (against it).
- A measurable time difference emerged: the eastward clock lagged, while the westward clock gained time.
- Conventionally, this phenomenon has been explained through a combination of special and general relativity.

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### Interpretation Based on Tensor Structure Theory

- The eastward direction (aligned with Earth's rotation) is considered closer to a resonant axis, implying a smaller tensor intersection angle $\theta$ and thus higher interference.
- The westward direction, being non-resonant, results in $\cos(\theta) \approx 0$, implying minimal interference.
- Therefore, the eastbound flight traverses a greater number of tensor structures, leading to more temporal retardation.

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**Assumed Values**

- Flight duration: $\tau \approx 37.1$ hours = 133,560 seconds
- Speed: $v \approx 250$ m/s
- Travelled Distance: $L = v \times \tau \approx 250 \times 133{,}560 = 3.339 \times 10^{7}$ m
- Time difference: $\Delta t \approx -59$ nanoseconds (eastward) = $-5.9 \times 10^{-8}$ seconds

**[Calculation of Loss Coefficient $\alpha$ (Eastward Direction)]**

$e^{(-\alpha L)} = 1 - (|\Delta t| / \tau)$

$\alpha = -\ln(1 - |\Delta t| / \tau) / L$

$\alpha \approx -\ln(1 - (5.9\times10^{-8} / 1)) / (3.339\times10^{7}) \approx 1.77 \times 10^{-15}$ [1/m]

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**【Conclusion】**

- The time delay observed in the eastward flight experiment can be interpreted as resulting from passage loss along the tensor-structured direction (eastward).
- The calculated loss coefficient $\alpha \approx 1.77 \times 10^{-15}$ [1/m] is two orders of magnitude smaller than that for GPS correction ($\alpha \approx 2.27 \times 10^{-13}$), which can be attributed to differences in altitude and velocity.

**Conclusion**

- The time delay observed in the airplane experiment can be interpreted as resulting from energy loss due to tensor passage along the aligned direction (eastward).
- The loss coefficient $\alpha \approx 1.77 \times 10^{-15}$ [1/m] is two orders of magnitude smaller than that of GPS correction ($\alpha \approx 2.27 \times 10^{-13}$), which can be attributed to differences in altitude and velocity.

**Section 3: Redefinition of GPS Satellite Time Correction**

**Comparison Between GPS Time Correction and Tensor Loss**

**[Objective]**

This supplement examines the consistency of the tensor loss coefficient model ($\alpha$), which is based on spatial tensor structure and travel distance, using the observed time correction of GPS satellites. Instead of relying on relativistic interpretations, it explains time modulation as energy attenuation caused by altitude, velocity, and directional interactions with the tensor structure.

[Observed Phenomenon]

- GPS satellites orbit the Earth at an altitude of approximately 20,200 km with a speed of 3,874 m/s.
- Their onboard clocks advance about 38 microseconds ($3.8 \times 10^{-5}$ s) faster than ground-based clocks per day.
- Traditionally, this is explained as the result of general relativity (+45 $\mu$s) and special relativity (−7 $\mu$s) corrections combined.

[Interpretation Based on Tensor Structure Theory]

- At the satellite's altitude, the tensor density is low, resulting in fewer passage interferences (lower time loss).
- Therefore, a correction is required to account for the faster time progression compared to the ground.
- Assuming the loss is proportional to $\alpha \times L$, it is described using exponential decay:

$\Delta t = \tau \times (1 - e\text{^}(-\alpha L))$

[Mathematical Validation]

*Assumption for travel distance (1 orbital period around Earth):*

- $L = 43{,}200$ sec $\times$ 3,874 m/s $\approx 1.672 \times 10^{8}$ m
- $\Delta t = 3.8 \times 10^{-5}$ seconds (observed correction)

*Reversely solving for the loss coefficient $\alpha$:*

$e\text{^}(-\alpha L) = 1 - (\Delta t / \tau)$

$\alpha = -\ln(1 - \Delta t / \tau) / L$

※Assumption: $\tau \approx 1$ second (considered as correction per unit time)

Calculation:

$\alpha \approx -\ln(1 - 3.8 \times 10^{-5}) / (1.672 \times 10^{8}) \approx 2.27 \times 10^{-13}$ [1/m]

Conclusion

- The time correction observed in GPS satellites is attributed to the lower attenuation in environments with low interference density in the spatial tensor structure.
- The coefficient $\alpha \approx 2.27 \times 10^{-13}$ [1/m] is derived using the same definition as in the airplane experiment, ensuring theoretical consistency.
- This value of $\alpha$ can be adopted as a unified reference for comparison with other experiments in the future.

## Section 4: Structural Reinterpretation of Muon Longevity

### Muon Lifetime Extension and Reinterpretation via Tensor Structure

[Objective]

This supplement reinterprets the phenomenon in which muons reach the ground from the perspective of spatial tensor structure. Unlike the previous supplements that applied the attenuation coefficient $\alpha$ in a distance-based model, this section introduces a unique model of structural longevity.

[Background and Observed Facts]

- Muons ($\mu$ particles) are produced at high altitudes (approx. 15–20 km) due to collisions with cosmic rays.
- Rest-frame lifetime: $\tau_0 \approx 2.2 \times 10^{-6}$ seconds.
- To reach the ground, they must travel ≈ 20,000 meters, but with this lifetime they should only travel ≈ 660 meters.
- Nevertheless, many muons are observed at the ground level (a longevity phenomenon).

[Conventional Theory]

- Special relativity explains this by time dilation due to high-speed motion ($v \approx 0.998c$).
- However, this explanation depends on the observer's frame of reference and lacks structural integration with space.

[New Interpretation Based on Tensor Structure]

- Muons are likely to travel immediately after formation toward non-resonant directions or regions with minimal interference.
- Consequently, the number of tensor intersections becomes minimal, reducing structural losses and allowing intact arrival at the ground.
- In other words, the muon's time did not slow down; rather, its structure was not eroded, resulting in an observed extension of lifetime.

[Numerical Comparison (for reference)]

- Distance at rest: $d = v \times \tau_0 \approx (2.994 \times 10^8\ \text{m/s}) \times (2.2 \times 10^{-6}\ \text{s}) \approx 658.7$ meters

- Required distance: 15,000–20,000 meters → under normal conditions, the muon should decay before reaching the ground.
- However, the observed result can be interpreted as a "corridor of longevity" formed by the non-uniform tensor density in space.

[Conclusion]

- The longevity of muons is not caused by the $\alpha$-based loss model but by the presence of selective, low-interference paths within the tensor structure.
- This represents a distinct category from airplane and GPS experiments and should be treated as an independent supplement under a theory of structural longevity.

## Section 5: General Review (Comprehensive Assessment and the Significance of the Loss Coefficient)

### Comparison and Evaluation of Temporal Energy Loss

### — Final Summary and Distance-Based Unification —

[Objective]

This section presents a unified comparison of the temporal loss hypothesis based on tensor passage structures. It evaluates whether a coherent model emerges through comparison of observational data from GPS satellites, aircraft experiments, and stationary ground clocks—using the loss coefficient $\alpha$ and passage distance as a common framework.

**[Subjects for Comparison]**

1. GPS satellites: High altitude, high speed, time correction of +38 microseconds per day
2. Aircraft experiment (eastward): Low altitude, low speed, correction of approx. −59 nanoseconds
3. Stationary ground clocks: Baseline (assumed to experience maximum loss)

**[Recalculated Coefficients (for reference)]**

- GPS: $\alpha \approx 2.27 \times 10^{-13}$ [1/m]
- Aircraft: $\alpha \approx 1.77 \times 10^{-15}$ [1/m]
  *Note: Both use the unified form* $\alpha = -\ln(1 - \Delta t / \tau) / L$
- Muons: Not applicable under this model (extended lifetime via different spatial structure)

[Evaluation and Considerations]

- The aircraft shows a smaller $\alpha$ value than GPS due to lower altitude (higher density) and shorter distance.
- Conversely, the GPS system travels at high altitude over longer distances, so even with a smaller $\alpha$, cumulative loss requires a larger correction.
- Both are logically consistent when viewed through the lens of direction, velocity, altitude, and passage distance, affirming the coherence of a distance-based $\alpha$ model.

[Summary]

- By deriving the loss coefficient $\alpha$ from passage distance, temporal modulation can be explained without invoking relativity, yet with physical consistency.
- All observable time-related phenomena on Earth and in space can be reinterpreted through spatial tensor structure and interference density.
- Future applications include the development of **distance-loss maps** and **tensor structure atlases**.

Note on Software and Computational Environment

In verifying the "tensor passage count (N)" and "temporal loss amount ($\Delta t$)" discussed in this chapter, the following astronomical computation libraries (or equivalent functionality) were utilized:

- **Skyfield** (Python library): Used to accurately compute Earth's rotation and observer vectors based on the JPL ephemeris.
- **Astropy** (Python library): Used for time conversions and coordinate transformations (e.g., between equatorial and horizontal coordinate systems).
- **NumPy / SciPy**: Employed to perform vector-angle calculations between observation vectors and tensor axes, including inner products and $\cos\theta$ values.

By integrating these tools, spatial vector alignments for specific observation locations and times were calculated and compared with the derived formulas for tensor passage counts and temporal losses.