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# Multidimensional Temporal Constructs: Non-Scalar Geometries of Time

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**Abstract:** ***This essay presents a conceptual extension of classical time models by building on a three-directional temporal framework characterised by an orthogonal (t,θ)-plane and a slightly skewed τ-axis. Dissenting from Minkowski's symmetrical spacetime, the model establishes a dynamic interaction between the future and past cones, contrasting with conventional frameworks that treat these structures as causally disconnected. It integrates probabilistic mechanisms governing event realisation and non-realisation, with realised events exhibiting exponential probability growth and non-events decaying via a power-law distribution before tunnelling into the past cone. The model incorporates a dynamic memory effect, wherein all events – including non-realised ones – leave traces influencing future probabilities without imposing determinism. By assigning a minute skew (0.00539°) to the τ-axis, the resulting time cones introduce an inherent anisotropy, breaking the traditional isotropy assumption of time. These modifications result in a structured, non-deterministic model of temporal progression and suggest observable implications at both quantum and cosmological scales. The work builds upon prior essays and proposes a unified structure where time emerges from the interaction of probabilistic events rather than from an intrinsic flow.***

**Keywords:** 3S + 3T, temporal symmetry, hyperbolic time cones, cosmological anisotropy, Planck-scale physics

## 1. Introduction

In traditional physics, time is treated as orthogonal to space, with the light cones forming a central framework for understanding causality, typically represented by 45° angles in the space-time diagram, as introduced by Minkowski in his 1908 lecture. However, this orthogonal treatment of time has always been an approximation, relying on specific unit choices rather than on a fundamental necessity of temporal evolution. The present work expands on previous publications, investigating event probabilities, the arrow of time, and quantum mechanics. It develops further earlier discussions on event filtering within the future cone, causality, probability, and gravity, moving beyond the constraints of classical frameworks [1]. Incorporating a slight skew of the $\tau$-axis relative to the $\theta$-axis (precisely set at 0.00539º), this modification not only defines the asymptotes of the time cones but also breaks the orthogonality of previous and conventional models, introducing an inherent anisotropy in the temporal structure. With the $\theta\tau$-plane dynamically shifting along the perceived time axis $t$, this framework extends previous discussions on event densities within the future cone and the passage of events into the past cone. Moreover, the inclusion of non-realised events as integral components of the event spectrum enriches the model, proposing a more dynamic, non-deterministic approach to time. The proposed refinements move the model beyond speculative dimensionality into a framework with potential physical implications. The skewed $\tau$-axis challenges the assumption of isotropic spacetime in standard cosmology, while the role of non-events questions the binary event ontology of traditional quantum mechanics. Situated at the Planck scale, this model offers a bridge between abstract temporal constructs and empirical physics, paving the way for testable predictions in both cosmological and quantum contexts in the future.

This model offers a conceptual bridge between the quantum and cosmological domains by introducing a structured temporal geometry capable of describing both local event dynamics and large-scale anisotropies. It challenges the standard view of time as a scalar or coordinate axis, and instead proposes a three-dimensional framework that accounts for causal asymmetry, memory decay, and event realisation without invoking curvature or extra dimensions. By doing so, it reframes persistent issues in physics – such as the collapse of the wavefunction, temporal non-locality, and the origin of cosmic structure – as geometric consequences of time's internal architecture.

## 2. Skewed τ-Axis and Its Implications

Conventional physics has long accepted light cones as the fundamental structure of causality, with their 45° angles dictated by the speed of light. Time hyperbolae arise from the introduction of light cones in Minkowski spacetime representing surfaces of equal proper time, and influencing the structure of event propagation. However, this perspective relies on unit choices rather than an intrinsic necessity of time evolution [2]. In the latest essay, the possible role of the $\tau$-axis in shaping the time cones was briefly mentioned, without providing more precision [3].

This essay now specifies its role and characteristics: the $\tau$-axis is assigned a skew of 0.00539° with respect to the $\theta$-axis, altering the formerly orthogonal framework. From this point forward, the skew angle of $\tau$ is treated as a defining feature of the emerging anisotropic time model. This minute adjustment, though seemingly trivial, introduces a directional anisotropy into the model. The result is the emergence of a new structure: time cones, which differ from light cones in that their apexes do not originate at $t = \theta = \tau = 0$ as light cones do, and no longer from a spatial origin $x = y = z = 0$ either. Instead:

- The skew angle causes the future and past cones to shift by $\pm\, l_P$ (Planck length) from the origin of the system. This shift introduces a directional component to the system, and as a result, the cones are no longer isotropic in the distribution of events across time, and the entire causal structure is shifted, albeit minimally.
- Event accumulation near the apex is now slightly denser than in the former orthogonal model. As a result, the gap opening was enlarged, allowing more events to pass through it from a well-defined volume of the future cone. Also, the skew-induced anisotropy is supposed to change

the event flow, guiding it in the direction of the skew, thus altering the internal event distribution in the future and past cones.

- The expected small drift remains negligible for the overall passage of events, though it produces a tiny, systematic alteration in how events are distributed, particularly near the skewed direction of the cones.

As time progresses, the skewed $\theta\tau$-plane moves synchronously forward along the $t$-axis, providing a hyperbolic framework for event evolution, with $\tau$ acting as an asymptotic boundary for the causal structure. Yet, the resulting drift in this plane remains negligible for the overall dynamics of event passage through the gap, and its effect on event distribution of events near the apex due to the induced directional bias is minimal.

From this point forward, the skew angle of $\tau$ is considered a fundamental characteristic of the still developing anisotropic time model. Events aligned with the skew may have a slightly different causal relationship compared to those farther away:

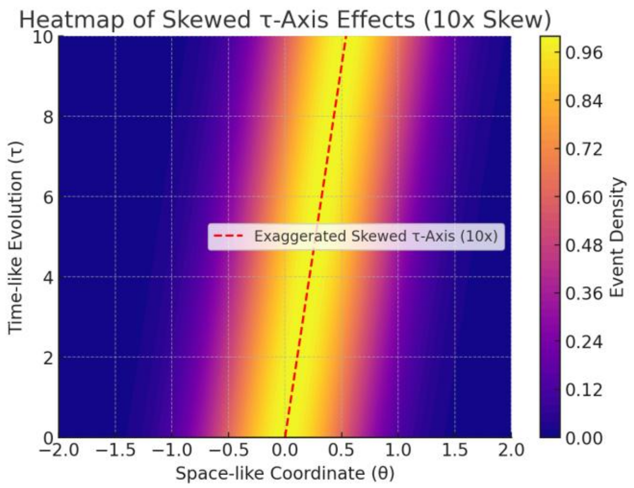


**Figure 1:** Effects of the skewed $\tau$-axis (heat-map, inclination exaggerated 10x)

Regarding simultaneity, the directional bias introduced by the skew will cause a nearly imperceptible, non-uniform progression of the $\theta\tau$-plane over time, subtly challenging the traditional notion of simultaneity in an orthogonal framework. Despite this, the overall framework remains intact – cones retain their hyperbolic shape – and anisotropy altering internal event distributions.

## 3. Defining Non-Events and comparing with Realising events

### 3.1 Defining Non-Events

One might wonder why in the previously presented model only events are responsible for progressing time. In fact, this is not the case, since realised events are supposed to be largely outnumbered by non-events, at a newly estimated ratio of $1{:}10^5$. This estimate is based on the fact that quantum fluctuation rates are in the range of $10^{104}$ per cubic metre; these event candidates include fluctuations, wave-function overlaps, and interaction points which could, in principle, become part of the realised causal chain. This means that by far not all these $10^{104}$ fluctuations can be considered as realising events or non-events, respectively. Consequently, the number of events passing with $P=1$ is revised from the former estimated value $10^{23}$ to $10^{24}$, thus maintaining consistency of the model.

All events in the future cone initially have a probability of realisation greater than zero. Non-events also begin with a certain probability but, for probabilistic reasons, fade to $P = 0$ without ever realising – though not into oblivion, as the following questions arise: if there are only realised events contributing to the progression of time, how can non-realised events be accounted for? Do they linger indefinitely in the future cone? Will they generate a muffled background noise of indetermination? Would this lead to an overcrowding of the future cone with events that never happened, competing with those that still have a chance to realise?

A useful analogy in this context is that of a parabola: in a physical experiment, an experimental outcome yields zero. Scientifically speaking, this is a result! Similarly, in human experience, expected events that fail to realise are not forgotten: they persist in our minds as memories, often influencing decisions to take in the present.

Thus, in this model, non-events are defined on the same premises as realised events: both contribute to the evolution of time, but in different ways. Non-events, rather than being discarded, are integrated into the past cone, leaving traces that may influence future realisations. More precision to this analogy will be given in a later chapter.

### 3.2 Different Behaviour, Conditions, and Effects of Realising *vs.* Non-Events

Realising events are passing through the Planck-scale gap, considered as a permissible transition window, with tremendous frequency into the past cone – whereas non-events are populating it at an even higher ratio. The choice of a quantum system allows for both events and non-events, as well as their probabilistic transitions, to co-exist near the apex of the future cone. This is because scale and volume in a quantum context are less restrictive than in the macroscopic world.

Each event has at least one timeline. As the apex of the future cone advances, certain timelines may become entangled, thus forming a “Zeitstrang” (Muchow 2020). However, this does not imply that the realisation of the event constituted by such a Zeitstrang becomes more probable. Complex Zeitstränge are primarily those generated by human decisions and other beings able of reasoning, even if their capacity for reasoning is minimal. In contrast, probable events with one or only a few timelines generally are considered to possess a purely physical origin.

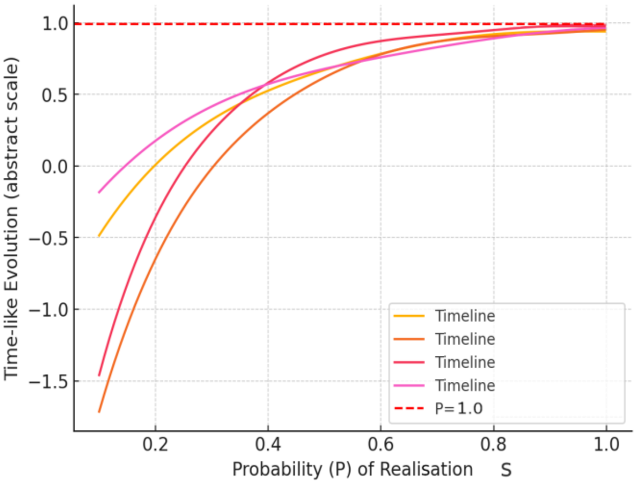


**Figure 2:** Converging probability paths in a Zeitstrang

As an event approaches the future cone's apex, generally its probability of realisation increases. Within a certain small volume at the bottom of the future cone, due to the filtering process increasing the density of events. These feature a probability very close to 1. When P reaches exactly 1, the event will pass through the gap into the past cone. The transition region and volume for realising events in the future cone were estimated previously (Muchow, March 2025). After the passage through the Planck-time gap, as defined in previous essays, the event leaves a distinct trace in the past cone.

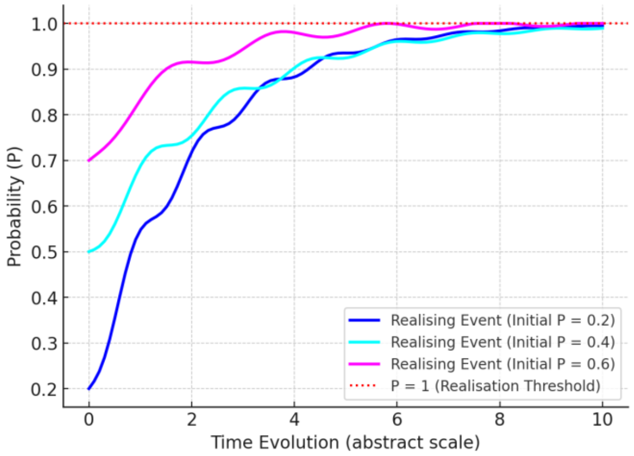


**Figure 3:** Probability evolution of events

Although still speculative, new adjustments had to be made, since the ratio of events to non-events was drastically adjusted, from 1:100 to 1:$10^5$. Thus, the new considerations led to an enlargement of the permissible transition window, the gap. In addition, the necessity arose to assure that the transition zone does not have sharp boundaries, but rather present a "gray zone", where some events with P = 1 may compete for realisation. This soft boundary is situated in an approximate distance 1.5 $l_P < d <$ 2.5 $l_P$ from the apex of the future cone. This, and the reconsideration of the tunnelling conditions for non-events will be treated in the next chapter.

As defined earlier, a non-event is characterised by a diminishing probability of realisation. When a non-event reaches the same volume in the bottom of the future cone as events with $P = 1$ occupy, it obviously cannot pass through the gap, since its probability is significantly less than 1. Instead, it undergoes a tunnelling mechanism, allowing it to pass directly into the past cone. As explained below, this tunnelling occurs at an estimated cut-off $\varepsilon$ value:

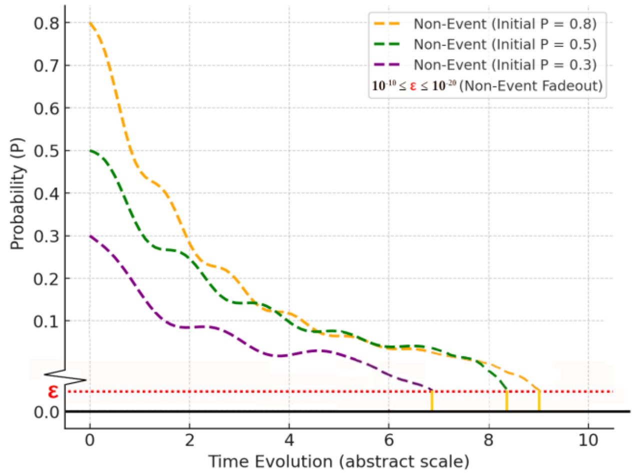


**Figure 4:** Probability evolution of non-events

The vertical yellow lines in the graph indicate the tunnelling moments when a non-event's probability drops below the $\varepsilon$-threshold, leading to its transition into the past cone.

This mechanism is connected to principles from quantum mechanics and probabilistic events, thus non-events exhibit a quantum-like behaviour. It does not require a deterministic or fully-realised passage but rather treats the non-event as a "phantom" that influences the system in a way that is consistent with the quantum nature of events and non-events. Also non-events entering the past cone leave traces. However, the intensity of the trace left by non-events in the past cone depends on its initial probability of realisation and is not comparable in intensity to the traces left by events:

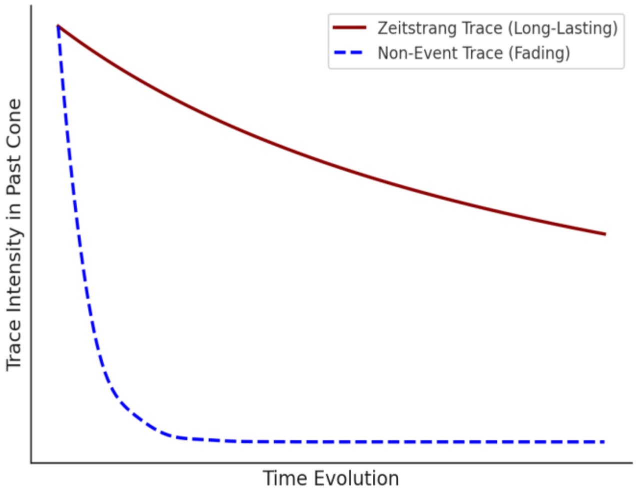


**Figure 5:** event traces *vs.* non event traces in the past cone

Events passing through the transition window with $P = 1$ produce distinct, persistent traces directly associated with their Zeitstränge. The more timelines in a Zeitstrang, the stronger and more enduring the trace in the past cone. In contrast, non-events reaching this cone via tunnelling leave weak, rapidly fading traces.

## 4. Mathematical Dynamics of Probability Evolution, Tracing and Event Realisation

To strengthen the proposed framework, it is essential to mathematically describe the key processes governing event realisation, non-event probability evolution, and related phenomena. This section introduces functions governing the probability evolution of realising and non-events, the filtering mechanism at the Planck-scale gap, and the memory effects of non-events in the past cone.

### 4.1 Defining Probability Evolution

The probability density function (PDF) governing event occurrence is:

$$P(d) = \lambda e^{-\lambda d}$$

with $\lambda$ as the event rate per unit length (or time), and $d$ the interval between two consecutive events. This distribution models the continuous spacing of events, indicating how long until the next event occurs.

For event realisation, it suggests that the likelihood of an event happening increases exponentially as it moves toward the permissible transition window.

Conversely, non-events undergo a negative probability evolution, as their probability of realisation becomes so low that, when reaching the cut-off value $\varepsilon$, they are transferred by a tunnelling mechanism into the past cone, where they eventually fade into insignificance.

Unlike deterministic models, where outcomes are fixed, the probabilistic nature of events and non-events allows for continuous evolution of their probabilities depending on time, and possible interactions with other timelines.

Each event initiates a timeline with an initial probability $P_0$, which tends to increase for factually occurring events. For non-events, however, the initially non-zero probabilities decrease as they approach the apex of the future cone. Their combination of decreasing probability and closeness to the apex is a prerequisite for failing to realise. Tunnelling occurs when the $\varepsilon$-threshold is reached, but non-events may also tunnel earlier from the calculated small volume, where events with $P = 0$ or very close to it are capable of jumping the gap. Since their probabilities are low when tunnelling, non-events leave only subtle traces in the past cone. While they may influence the overall system dynamics, they do not directly drive the progression of time.

The general probability evolution following an exponential form is a natural consequence of probabilistic decay. Events either realise when $P \rightarrow 1$ or become inevitably non-events when $P$ drops below $\varepsilon$, triggering tunnelling into the past cone. The $\varepsilon$ cut-off for non-events can be probabilistically estimated on the basis of Planck length $l_P$ and PTU with a spatial-temporal resolution ratio:

$$\varepsilon \sim \frac{l_P}{PTU},$$

yielding a range of $\varepsilon$ between $10^{-10}$ and $10^{-20}$. This threshold determines when a non-event ceases to leave a significant trace, but does not dictate the likelihood of tunnelling itself. However, it marks the limit below which non-events must tunnel into the past cone and will leave no significant trace.

Non-realised events, considered as de facto events, capable of tunnelling into the past cone, can thus be described probabilistically by the parameter $\varepsilon$:

$$|\psi|^2 < \varepsilon$$

$\psi$ represents the state function of an event timeline, with its squared modulus corresponding to realisation probability. This condition formally defines the boundary where non-events transition into the past cone, ensuring a structured distinction between realised and non-realised events within the framework.

### 4.2 Memory Effects and Traces of Events

As mentioned earlier, both events and non-events leave a trace in the past cone. Yet, this does not imply determinism, which would require these traces *must* lead to an influence on future events. Within the framework of the model, traces events leave in the past cone only tweak probabilities slightly.

The memory function of events and non-events can be expressed with the following proportionality:

$$M(t) \propto \frac{1}{(1+t)^p}$$

where $p < 1$ applies for non-events with an initial $0 \leq P_0 < 1$, indicating that their traces fade according to their initial probability $P_0$ in the future cone. In order to transform it into a valid equation, a constant must be chosen, which is defined as:

$$M_0 = \alpha P^\beta$$

with $\alpha$ as the normalisation constant, and $\beta$ determining how $P_0$ affects the memory strength, one obtains:

$$M(t) = M_0 \frac{1}{(1+t)^p} = \alpha P_0^\beta \frac{1}{(1+t)^p}$$

which is the memory function of events over time. Thus, for events leaving a significant trace in the past cone, $\beta$ is estimated to be close to 2. In contrast, non-events – having a weaker impact there, and fading more rapidly – have $\beta$ values between 1 and 1.3.

While non-events follow the same fundamental principles as realising events, their declining probability and rapid fading mean they influence the system differently by directly tunnelling into the past cone. However, they still contribute to time's progression by affecting the overall structure of realised and non-realised events. Although non-events do not follow the same principles as realising events, their declining probability in the future cone and their rapid fading traces in the past cone mean they influence the system subtly, without directly shaping the primary sequence of event realisation.

The trace strength $T$ for events can be heuristically modelled as a function of their initial probability $P_0$, with higher initial probabilities leading to longer-lasting traces. A possible decay form might be:

$$T \sim P_0 e^{-\lambda t}$$

where $\lambda$ determines the rate of fading. Obviously, $\lambda$ is high for events that passed the gap and much lower for non-events that tunnelled to the past cone. The exact formulation remains speculative, but the essential idea is that non-events with low initially $P_0$ fade quickly, while those with high $P_0$ persist longer.

These formulations provide a mathematical foundation for understanding the evolution of probabilities in the event-realisation process. They also clarify the subtle but structured influence of non-events, ensuring a consistent integration of realised and non-realised events into the timeline structure. Future refinements could further quantify the impact of memory effects on probability distributions and the role of tunnelling thresholds in defining event persistence.

### 4.3 Event Realisation

It is indispensable to propose a mechanism describing event realisation. A different approach is chosen for events and non-events:

For realising events, the transition through the permissible transition window occurs at $r \leq 2\, l_P$, provided their $P=1$, with $r$ equalling the event's distance from the axis, $r_0$ being the transition point where $P = 0.9$, and $n$ being a factor controlling the increase of $P$:

$$P_{event}(r) = 1 - e^{-n \cdot (r - r0)}$$

The probability rises until $P = 1$, marking the event's realisation. This process is illustrated in the following figure:

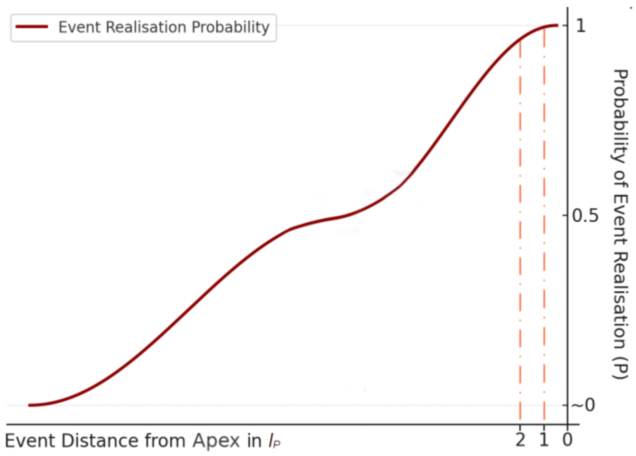


**Figure 6:** Event realisation probability increase

It is evident (compare fig.3) that this mechanism is closely related to the probability evolution of events.

Unlike realising events, whose probability development follows an exponential increase, non-events exhibit a power-law decrease. Here, $m$ is the decay factor controlling the rate at which $P$ declines:

$$P_{\text{non-event}}(r) = 1 - \left(\frac{r_0 - r}{r_0}\right)^m$$

This is visualised in the following figure:

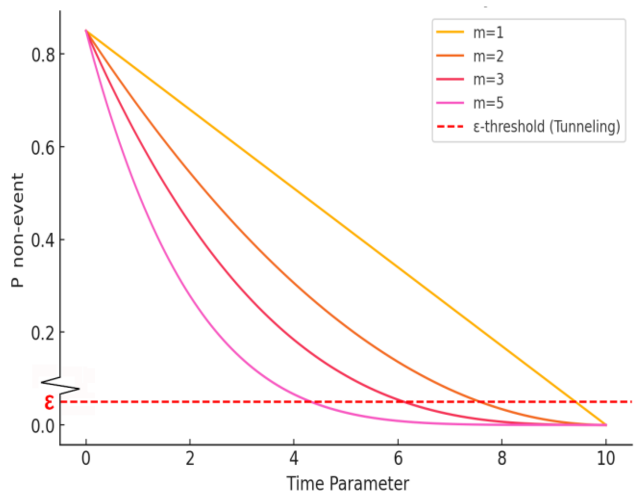


**Figure 7:** Non-event probability decrease

Before reaching the cut-off value ε, tunnelling may occur, but at ε, it must realise as a non-event.

It has been shown that the probabilistic dynamics of event realisation and non-event decay are fundamentally distinct: events follow an exponential increase in probability, while non-events are governed by a power-law decay. The transition points and threshold for tunnelling into the past cone provide a clear demarcation in the behaviour of these two types of events, and the factors $n$ and $m$ govern the rates of change in both cases. These mechanisms lay the foundation for understanding the evolution of events in the proposed model.

## 5. Discussion

While conventional models treat time as orthogonal to space, with light cones forming the central structure for causality, the incorporation of a slight skew challenges this orthogonality and moves toward a more nuanced, anisotropic framework. Although the skew is small, it has a profound impact, subtly altering the way events and non-events evolve, and leading to directional probability distributions. As demonstrated, the skewed $\tau$-axis introduces a significant modification to traditional time models by introducing an inherent anisotropy in time.

Since the results of the COBE Mission, there is a growing understanding that the CMB is not completely isotropic, as significant anisotropies have been detected in the early universe [4]. The structure of the presented model inherently implies a subtle time-dependent variation in physical laws and an observable directional bias, potentially leading to the observed cosmological anisotropy. The detected anisotropies contrasts with the conventional view of time as isotropic, where no such bias or directionality is assumed. Thus, this model offers new insights into the nature of time, where the $\tau$-axis's asymptotic behaviour defines the future and past cones, influencing how events and non-events evolve.

In quantum mechanics, the asymmetric treatment of realising *vs*. tunnelling events would suggest a deeper link between probability evolution and temporal directionality. Non-Markovian memory effects, such as those discussed in the cited references [5], provide a framework for understanding how past states influence future probabilities, and resonate with the event traces in the past cone described by this model. While speculative, these effects warrant further exploration, particularly regarding how time's anisotropy might manifest empirically. Unlike in conventional models where events are seen as deterministic (or non-probabilistic in their realisation), this framework introduces a quantum-like behaviour for non-events, whose probabilistic decay and fading traces they occasion in the past cone align them more closely with quantum superposition than with classical mechanics.

In traditional physics, non-events are typically treated as irrelevant, or simply as a binary state: either an event occurs or it does not. By contrast, defining non-events as entities with declining probabilities of realisation, and their eventual tunnelling into the past cone makes them unquestionably different from realising events, which experience an exponential increase in probability until reaching their transition level.

Furthermore, this model's temporal progression is not governed by an inherent flow of time, as often stated in conventional interpretations of the arrow of time. In contrast, the model proposes that time itself is emergent, shaped by events: they happen, probabilistically, without a flowing mechanism. The memory effect in this model, where traces of all events subtly influence future probabilities, further departs from traditional time structures, where time flows independently and smoothly.

*The temporal progression exists solely because events happen; there is no inherent flow of time.*

The mathematical framework used here further contrasts sharply with conventional approaches. The exponential increase in probability of realising events and the power-law decay of non-events highlight a distinct probabilistic nature of event evolution. In traditional models, event realisation is deterministic, with little to no space for non-events. This framework, however, treats the passage of events through the transition window probabilistically, with the tunnelling of non-events into the past cone adding a layer of complexity not typically found in standard quantum mechanics or cosmological models. Similar probabilistic structures have been explored in studies on event probability distribution and stochastic evolution [6], supporting the approach presented here.

Timelines merge in the Zeitstrang concept. Yet, this merger does not increase the overall probability of realisation by adding single probabilities of the events merging, but they eventually may reach a final *P=1* together. Although there is no change in overall probability, it has an effect on the trace, such a Zeitstrang leaves in the past cone:

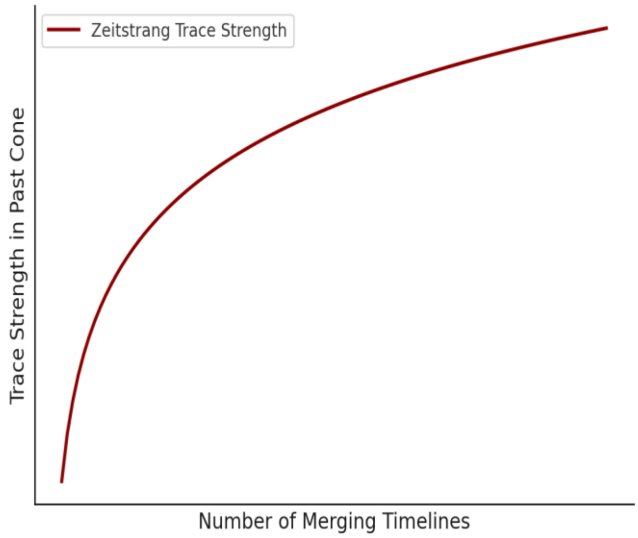


**Figure 8:** Trace strength of Zeitstrang events depending on accumulated timelines

The Zeitstrang concept distinguishes this model from conventional frameworks treating events as isolated occurrences, reflecting the probabilistic accumulation of timelines, and shedding light on the dynamic, evolving nature of events in time. Non-events, instead of being discarded, are tunnelling in a probabilistic manner, with their traces lingering in the past cone as they quickly fade.

The mathematical treatment of the memory effect through functions like $M(t)$ ensures that the model can quantitatively assess the effects of traces, whether strong or subtle, left by events and non-events alike [7]. Moreover, the memory effect associated with events and non-events, where each leaves a trace in the past cone, offer a unique mechanism for understanding how past occurrences continue to influence future probabilities, yet without imposing determinism.

The notion of event realisation in this framework demonstrates a non-deterministic approach to time. The probabilistic passage of events through the transition window and their realisation when $P = 1$ emphasises the inherent uncertainties and probabilistic nature of the process. In contrast, non-events, governed by a decaying probability, tunnel into the past cone once their probability falls below a certain threshold, further highlighting the distinction between realised and unrealised events.

Opposing to Minkowski's flat, four-dimensional continuum, the proposed 3S + 3T model abandons orthogonality but preserves flatness to a high degree. Time is no longer a scalar axis in Einsteinian spacetime, but a three-dimensional structure, with $\tau$ serving as the asymptotic axis of temporal progression. A directional skew in both time and space is introduced, subtly tilting $\tau$ relative to $\theta$, and $z$ relative to $x$, placing Space and Time in superposition. Events are no longer situated by metric properties alone, but through realisation dynamics: probabilistic filtering, tunnelling behaviour, and anisotropic emergence across cones defined by $\tau$.

Minkowski's spacetime draws the axes of the light cones at a 45° angle, imposing metric and symmetrical attributes (Minkowski 1908). In a sharp contrast to Minkowski's model, the presented model is non-metric, anisotropic, and causally biased through the opening of the 45° angle to nearly 90°, yet retaining local flatness and avoiding curvature: we observe phenomena as they present themselves. Crucially, it invokes interaction between the time cones themselves, which were considered static and non-interacting by Minkowski and his followers.

Departing from the conventional orthogonal system, this model offers a speculative yet structured perspective on how events, non-events, and their associated traces interact within a dynamic timeline structure. If the skew of the τ-axis introduces a directional bias in event distributions, future research may provide a way to empirically test for such an effect. *In fine*, the proposed system demands a novel perspective on the three-directional nature of time, with implications for further research in cosmology and quantum mechanics. While the mathematical formulations provide a coherent framework, their precise applicability remains open to further refinement, and may eventually allow for greater precision in quantifying these effects.

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