Segmented Spacetime - A New Perspective on Light, Gravity and Black Holes

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The nature of spacetime and its interaction with light has long been a cornerstone of modern physics. Black holes, with their extreme gravitational environments, challenge our understanding of these fundamental principles. Traditional theories often portray black holes as regions of absolute information loss, where light and matter are irrevocably consumed. However, recent observations and theoretical developments suggest that these enigmatic phenomena may be more complex than previously thought.

This paper introduces a novel framework based on the segmentation of spacetime, a concept that describes how light interacts with gravitational fields. We propose that light entering a black hole undergoes a transformation, emerging as radio waves rather than disappearing entirely. This transformation preserves information, challenging the conventional notion of black holes as ultimate information sinks. By exploring the role of segmentation and rotation, we aim to provide a new perspective on the relationship between light, spacetime, and black holes.

Through a combination of theoretical analysis and connections to observational data, this work lays the groundwork for future studies that could bridge the gap between abstract theory and measurable phenomena. By rethinking spacetime as a segmented structure, we open new avenues for understanding the behavior of light in one of the most extreme environments in the universe.

Introduction to Segmented Spacetime and Light Waves

In our first article[1], we assumed a normal clock with a radius of 1 in the absence of gravitational forces. In this article, we want to discuss whether such a normal clock really exists in the universe.

Therefore, we are specifically looking for a natural normal clock with the following specifications:

$$2\phi \;=\; 2 \;*\frac{1}{4}*\; 2\pi \;=\frac{1}{2}*\; 2\pi \;=\; \pi$$

The formula $2\phi=\pi$ fits particularly well with circularly polarized light and our model of segmented spacetime, because:

Light waves can represent circular or spiral motion in their movement (especially with circular polarization). This circular motion of the electric and magnetic fields in circularly polarized light can be directly linked to a geometric circular motion (as in the formula).

Circularly polarized light is a special form of light waves in which the electromagnetic fields (E and B) not only oscillate sinusoidally, but also rotate as they propagate through space. For example, the electric field rotates like a rotating pointer, so that the motion describes a spiral or a circle.

Segmentation by ϕ and radius r=1 creates a natural connection to wave phenomena. With radius r=1 and frequency f=1, a natural resonance arises between the quantities ϕ and π.

The circular frequency (ω=2πf) and segmentation by ϕ could define the resonance between space and wave.

In our model of segmented spacetime, a light wave in a vacuum at a frequency of f=1 passes through exactly 4 segments per period. This can also be demonstrated mathematically:

The angular frequency ω is defined as:

$$\omega = 2\pi f$$

For f=1, we get:

$$\omega = 2\pi \cdot 1 = 2\pi$$

This means that the wave completes a full cycle (from 0 to 2π) in one complete period. The circle is divided into 4 equal segments, with the following segment boundaries:

$$0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}, 2\pi$$

Within one period (T=1), the wave passes through these 4 segments precisely.

When the frequency f increases, the angular frequency remains proportional:

For f=2: The wave passes through the circle twice in one period (T=1/f). This means that it passes through 8 segments (2 times the same 4 segments).

For f=3: The wave passes through the circle three times in one period and passes through 12 segments.

In general, the number of segments N passed through can be described as:

$$N = 4 \cdot f$$

Thus, it is mathematically correct that a light wave in a vacuum at a frequency of f=1 passes through exactly 4 segments per period. The relationship remains proportional for higher frequencies.

In a vacuum, the relationship holds:

$$c = \lambda \cdot f$$

where c is the speed of light, λ is the wavelength, and f is the frequency. As the frequency f increases, the wavelength λ must decrease correspondingly to keep c constant.

If f=N/4, we can express the wavelength in terms of N as well:

$$\lambda = \frac{4c}{N}$$

The wavelength becomes shorter as more segments N are traversed. For N=4 (one period with f=1), it can be seen that λ=c. For N=8, $\lambda = \frac{c}{2}$.

The radius of the wave r is directly linked to half the wavelength:

$$r = \frac{\lambda}{2}$$

As λ grows, the radius must also increase.

Classically, it is described that gravity stretches space, increasing the wavelength and raising the radius of the wave circle. This happens because spacetime itself is stretched, making the oscillations of the wave appear slower (time dilation).

In the theory of segmented spacetime, the increase in radius r corresponds to an increase in segments. With increasing gravity, space has more segments. Gravity adds more segments to space, and the wave must travel through more of these segments per period.

This also results in an extension of the wavelength λ, allowing the radius r to grow accordingly. The increase in radius r corresponds to an increase in the number of segments N, as the radius directly scales the space.

The relationship between gravity, radius, segments, and wavelength can be expressed as follows:

$$r = \frac{\lambda}{2}, \lambda = \frac{4c}{N}, r = \frac{2c}{N}$$

Here it can be seen that as the number of segments N (more gravity) increases, the radius r grows, and the wavelength λ extends.

Light has a wavelength of approximately 300,000 km, which corresponds to a circle with a large radius in normal conditions.

$$\lambda = \frac{c}{f} = \frac{299792458\,m}{1}$$

Light waves under the influence of gravity in segmented spacetime

Under the influence of gravity, the wave becomes longer, and a redshift occurs. Let's assume a frequency of f=0.5 Hz (half vibration):

$$\lambda = \frac{c}{f} = \frac{299792458\,m}{0.5} = 599584916\,m$$

Here, the wavelength is almost twice as large as in the normal state. The radius of the wave circle would double accordingly.

Light travels 299,792,458 m in 1 second. If we divide this distance by 4 segments:

$$Meters\ per\ segment\ = \frac{299792458\,m}{4}\ =\ 74948114.5\,m$$

Under the influence of gravity (redshift), light travels 599,584,916 m in 1 second with a larger wavelength and lower frequency. Its speed remains constant.

$$Number\ of\ segments\ = \frac{599{,}584{,}916\,m}{74{,}948{,}114.5\,m}\ =\ 8$$

This corresponds exactly to twice the original segments - as we would expect if the frequency is halved. The number of segments increases proportionally to the wavelength expansion (λ'), and light dynamically adapts to gravity by traversing more segments while maintaining a constant speed of light (c).

The number of segments (N) depends on the speed of light (c) and the distance per segment (d_s):

$$N = \frac{c}{d_s}$$

In a vacuum, $d_s = \frac{c}{4}$ holds true.

Under the influence of gravity, when the frequency changes to f' and the wavelength changes to λ', the following is obtained:

$$N' = \frac{c}{d_s} = \frac{c}{\frac{c}{4}} \cdot \frac{f}{f'} = N_0 \frac{\lambda'}{\lambda_0}$$

For:

$N_0 = 4$ **(segmentation in a vacuum)**

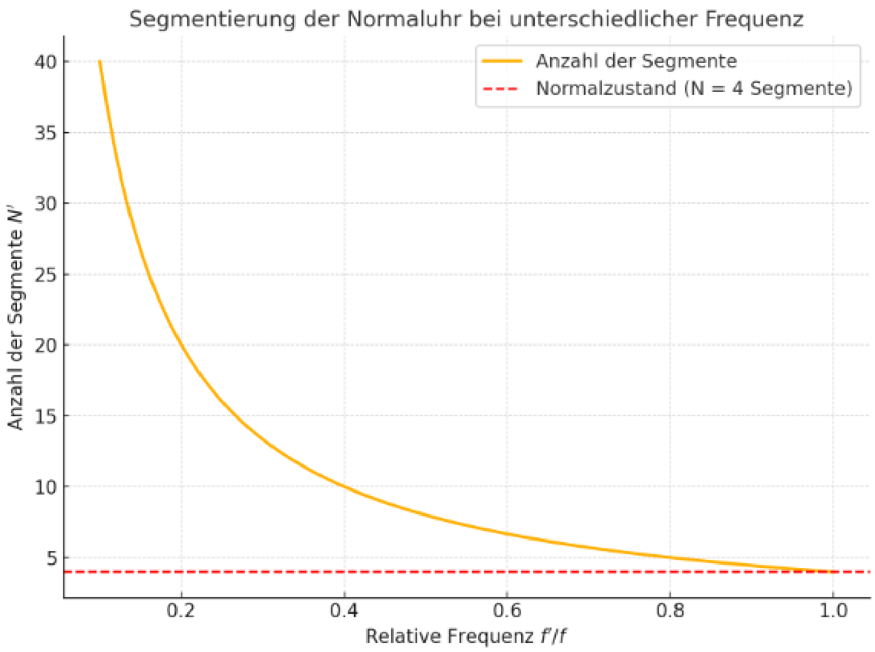
$\frac{\lambda'}{\lambda_0} = \frac{1}{\frac{f'}{f}} = \frac{f}{f'}$ **(change in wavelength)**

Sample calculation:

In a vacuum: $N' = 4 \cdot \frac{1}{1} = 4\,segments$

With gravity (f=1 Hz, f'=0.5 Hz): $N' = 4 \cdot \frac{1}{0.5} = 8\,segments$

Thus, conclusions about the segmentation of space can be drawn from the change in wavelength.



Segmentation inside a black hole

In a previous paper[2], our focus was on the space surrounding a Kerr black hole. This unique object is characterized as a rotating black hole, with its properties determined by mass and angular momentum. In extreme cases, when the spin parameter a=M is reached, it is referred to as a maximally rotating Kerr black hole, where the event horizon reaches its minimum possible radius. The mathematical peculiarities that arise in this context remain unresolved challenges, making the Kerr black hole a fascinating subject of study.

At the event horizon of a black hole, spacetime undergoes a fundamental transformation and essentially "tilts" or "folds." This boundary marks the point where gravity becomes so intense that the geometry of spacetime deviates radically from the structure we are familiar with. For this reason, the interior of a black hole cannot be treated in the same way as outer space. This also explains why the gravity of a black hole cannot be measured using conventional methods.

The visible space around the black hole behaves like a vacuum, while the invisible space within exerts immense gravitational forces. A black hole can therefore be considered a "space within a space," whose physical properties differ significantly from those of the external universe.

If we were to calculate the segmentation using Euler's formula, the segmentation would approach infinity. At the point where the spiral would close at a radius of 1, the segmentation tends toward infinity. Physically, this corresponds to the concept of infinite density, commonly referred to as a singularity. This behavior presents significant challenges to modern physics and forms the foundation of the singularity problem.

In this paper, we present a novel approach to addressing the problem of singularity by calculating the segmentation within black holes. Furthermore, we examine the behavior of light under these extreme conditions, demonstrating that light is not entirely trapped even within black holes. Our aim is to analyze this behavior in detail to gain a deeper understanding of the underlying mechanisms.

We define a new growth spiral for the interior of the black hole. The spiral originates at the center of the black hole (r=0) and expands logarithmically, with the radius increasing as the angle θ grows. The spiral terminates at the boundary of the circle (r=R), where R represents the actual radius of the circle.

To simplify the analysis, we set R=1, treating the system as dimensionless. This approach highlights the universality of the model, as any black hole with real-world dimensions can be understood as a scaled version of these conditions. By working with a normalized radius, the geometric relationships remain consistent and transferable, regardless of the black hole's physical size.

The general formula for the logarithmic spiral is

$$r(\theta) = \mathrm{r}_0 \cdot e^{k\theta}$$

Where $k = \frac{2\ln(\phi)}{\pi}$ is the growth rate of the spiral. The angle θ determines how many times the spiral twists before it reaches the edge.

The spiral ends, if r(θ)=R. It follows:

$$R = \mathrm{r}_0 \cdot e^{k\theta_{\max}}$$

To calculate the maximum angle θ_{max}:

$$\theta_{\max} = \frac{\ln(R/r_0)}{k}$$

If the midpoint is $r \to 0$ ist, we need to use a minimum starting value (f.e. $r_0 = 10^{-6}$), to avoid division by zero.

This adjustment does not distort the segmentation results for several reasons.

Firstly, the choice of a small but finite starting value ensures numerical stability without altering the overall behavior of the logarithmic spiral. The growth dynamics of the spiral are dominated by the logarithmic term, and the influence of the initial value r_0 becomes negligible as the spiral expands outward.

Secondly, since the segmentation primarily depends on the angular progression of the spiral and the logarithmic scaling of the radius, the starting point r_0 only determines the position of the first segment. The subsequent segmentation follows the same proportional growth pattern regardless of the specific value of r_0, as long as r_0 is sufficiently small.

Lastly, the use of a finite starting value is a practical necessity for numerical computations, and it reflects the physical reality that exact singularities (such as r=0) are idealized constructs. In practice, such singularities are not directly observed, and the introduction of r_0 aligns with the resolution limits of both theoretical and experimental approaches.

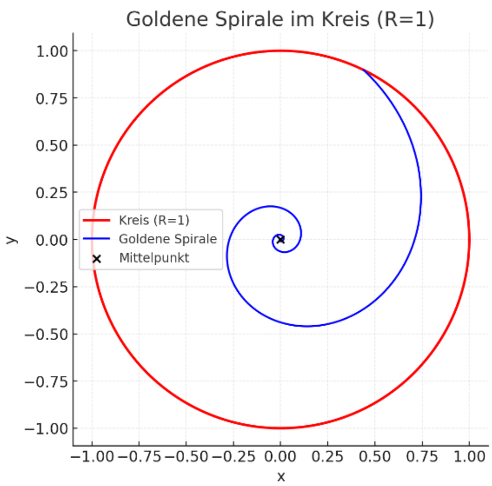
Therefore, the segmentation calculated from this approach remains valid and accurate, as it faithfully represents the behavior of the spiral under real-world conditions.

For every quarter turn ($\theta = \pi/2$) the radius increases by the factor ϕ. The relationship is:

$$r(\theta + \pi/2) = r(\theta) \cdot \phi$$

This means that the radius keeps multiplying by ϕ as the spiral grows. The spiral stops at the edge of the circle when r=R.

In practical terms, this means that the spiral does not continue to grow indefinitely, but is limited by the circle.



The segmentation was calculated using a custom Python script, which implements the formula to analyze the spiral behavior. For reproducibility, the script is included in Appendix A.

Using the Python script, we calculated the segmentation in the region near the event horizon of a black hole. The results demonstrated that the spiral structure at a radius of 1 exhibits a segmentation of approximately **4 million segments**. Contrary to traditional interpretations that predict infinite segmentation and lead to the concept of a singularity, our findings indicate that the segmentation stops at this finite value.

This result challenges the notion of a true singularity, suggesting instead that the segmentation is naturally limited. This limitation provides a new perspective on the behavior of spacetime near black holes, avoiding the paradoxes associated with infinite density.

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The number 4 million is not merely a result of the spiral calculation but a clue to the fundamental structure of the black hole. The base structure begins with 4 segments ($4 \cdot \phi^0 = 4$) and each segment grows proportionally to the logarithmic scaling of the spiral. This multiplication by ϕ^n results in a number that remains divisible by 4, as the starting value is 4.

Segmentation, Rotation, and the Nature of Light

The fundamental structure of space is defined by segmentation as soon as a photon appears. Instantly, it segments space into four fundamental segments and begins to rotate, immediately and without any acceleration. This is a unique characteristic of the light wave: It moves instantly at the speed of light (c), independent of gravity or external influences. This makes the concept of an ether unnecessary, as the light wave propagates directly through space without relying on a material medium.

Thinking in terms of matter, which is tied to acceleration, leads to conceptual problems. Here, the nature of the wave motion is fundamentally different - at best comparable to the fall of the Berlin Wall in the DDR: Everything happened “immediately and without delay.”.

Light and Gravity—A Common Misconception

When considering a black hole, it’s often assumed that light is slowed down by gravity. However, this is not the case. The gravity of a black hole does not affect the speed of light but instead compresses its wavelength. This compression reduces the wavelength to a point where it becomes invisible and extremely difficult to detect.

Since we succeeded in mathematically describing the segmentation inside a black hole, it now becomes possible to determine the range of minimum wavelengths for light within the black hole. These boundary values could provide new insights not only into the nature of light but also into the very structure of space and time.

We set therefore into our formula those findings:

$$\lambda = \frac{4c}{N}$$

$$\lambda = \frac{4 \cdot 299792458 \text{ m}}{4000000} = \frac{299792458 \text{ m}}{1000000} = 299.792458\, m$$

So we can now see that the gravity of a black hole compresses the wavelength of light into the range of short-wave radiation (radio waves). We cannot perceive this light with our eyes because our visual spectrum is limited to approximately 400 nm to 700 nm (visible light). Radio waves, on the other hand, have much longer wavelengths and can only be detected using specialized instruments such as radio telescopes. This is why a black hole appears black to us.

The frequency of a wave is inversely proportional to its wavelength. At a wavelength of 299.79 meters, the frequency is in the range of around 1 MHz (megahertz). Light waves compressed into the radio wave range with such low frequencies are only perceptible to us as signals (e.g., radio or radar) but no longer as "light." Radio telescopes could potentially detect these waves, especially if they originate from the event horizon or the vicinity of a black hole.

Radio waves are extremely compressed upon entering the black hole due to the segmentation within the black hole, which encompasses millions of subdivisions. However, upon exiting, the light is only shifted back by 4 segments, as the space surrounding the black hole corresponds to a segmentation of just 4. This discrepancy explains why light that is highly compressed and high-frequency inside the black hole appears also as radio waves outside of the black hole.

Let us see what happens when the light leaves the black hole again:

$$\lambda = \frac{4 \cdot 299792458 \text{ m}}{4000000 - 4} = \frac{4796679328 \text{ m}}{3999996} = 1199{,}171031171031\, m$$

$$f = \frac{299792458}{1199{,}171031171031} = 249.999{,}75\, Hz$$

The light in this case has now a wavelength of approximately 1.2 kilometers, which falls into the range of long-wave radio waves. The frequency of the wave is approximately 250 kHz or a bit higher.

Radio Waves and Information Transformation in Black Holes

Radio waves have indeed been detected near black holes, but their exact origin has remained unexplained. Our own supermassive black hole, Sagittarius A*, also emits radio waves, which have been observed using radio telescopes like the Very Large Array (VLA). These radio waves originate from the vicinity of the event horizon[3].

We propose that visible light enters the black hole and emerges as radio waves. During this process, no information is lost—the light is merely transformed. These radio waves could carry a temporal "signature" that provides clues about the original light source and its interaction with spacetime segmentation.

Through this temporal differentiation, it may be possible to trace how the original light wave was altered by gravity and segmentation. This approach could even allow for the reconstruction of the original information that entered the black hole.

Conclusion and Future Implications

The segmentation of spacetime provides a novel framework to understand the interaction of light and gravity near black holes. By proposing that visible light entering a black hole is transformed into radio waves, this model offers a fresh perspective on the nature of information preservation in extreme gravitational environments. This transformation challenges traditional views of black holes as ultimate sinks of information, instead suggesting a mechanism of redistribution and encoding.

Future observations and experiments, particularly those utilizing advanced radio telescopes like the Event Horizon Telescope or the Square Kilometer Array, could help confirm or refine this model. The detection of temporal signatures or specific polarization patterns in radio waves near black holes may provide the evidence needed to support this hypothesis.

This work highlights the importance of considering spacetime as a segmented structure, where the fundamental properties of light, rotation, and gravitation interplay in ways that can redefine our understanding of black holes and the universe itself.

References

1. Wrede, C., & Casu, L. (2024). Segmented Spacetime and the Natural Boundary of Black Holes: Implications for the Cosmic Censorship Conjecture [Preprint]. ResearchGate.

2. Wrede, C., Casu, L., Bingsi (2024). Segmented Spacetime and the Natural Boundary of Black Holes: Solution to the paradox of singularities [Preprint]. ResearchGate.

3. Hodge, P. W. (2024, October 30). *Sagittarius A**. *Encyclopedia Britannica*. https://www.britannica.com/place/Sagittarius-A-astronomy

Appendix A

```
import numpy as np


# Parameter der Spirale

phi = (1 + np.sqrt(5)) / 2  # Goldene Zahl (Phi)

S_start = 4  # Anfangssegmentierung (4 Grundsegmente)

r_start = 1e-6  # Minimaler Startwert nahe Null, um Division durch Null zu vermeiden

r_end = 1  # Endradius (R = 1)


# Berechnung der Anzahl der Schritte n entlang der Spirale

n = np.log(r_end / r_start) / np.log(phi)


# Berechnung der Endsegmentierung bei Radius 1

S_end = S_start * phi**n


# Ausgabe der Ergebnisse

print(f"Anfangssegmentierung: {S_start}")

print(f"Startwert des Radius: {r_start}")

print(f"Endradius: {r_end}")

print(f"Anzahl der Vierteldrehungen (n): {n:.2f}")

print(f"Endsegmentierung: {S_end:.0f}")
```