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Research paper

Hypothesis on black holes as dimensional portals and information preservation

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Abstract

Background: Black holes are traditionally viewed as cosmic entities from which nothing can escape, leading to the notion that information is lost when it crosses their event horizons. This idea is challenged by the information paradox, which raises questions about the preservation of information in light of quantum mechanics.
Objective: This manuscript aims to propose a new hypothesis that redefines the nature of black holes by suggesting they function as dimensional portals, preserving information instead of destroying it.
Methods: A mathematical model is introduced, featuring a teleportation function, T(D), that describes how information transforms when moving from our three-dimensional space into a higher-dimensional framework.
Results: The proposed hypothesis aligns with the principles of quantum mechanics, suggesting that information is retained in a different dimension and may enhance our understanding of black hole thermodynamics, including concepts like Hawking radiation and entropy.
Conclusion: The idea of black holes as dimensional portals offers a fresh perspective on the information paradox and presents new avenues for future research in both theoretical and observational physics.

Keywords: *Black holes; Dimensional portals; Information Preservation; Quantum mechanics; Hawking Radiation; Higher Dimensions.*

1. Introduction

Black holes have long been regarded as mysterious cosmic bodies from which nothing can escape, not even light. This understanding, considered in general relativity, portrays black holes as regions where matter and information are lost upon crossing the event horizon. However, this classical view has been challenged by developments in theoretical physics, most notably through Stephen Hawking's famous information paradox. This paradox arises from the tension between the laws of quantum mechanics, which demand the preservation of information, and the general relativistic description of black holes, which suggests that information is lost forever.
The information paradox has led to various speculative theories, such as the holographic principle and the firewall hypothesis, which attempt to reconcile this conflict. Yet, these theories often remain on the edge due to a lack of direct observational evidence. In this manuscript, we propose a novel hypothesis that posits black holes as dimensional portals, where objects and information crossing the event horizon are not destroyed but rather transported to another dimension. This hypothesis offers a fresh perspective on the information paradox, potentially reconciling the irreconcilable aspects of quantum mechanics and general relativity.
We suggest that the extreme gravitational environment of black holes might do a dimensional transition, preserving the information in an altered state within a different dimensional space just like conservation of energy. Information will change its state to survive in the environment. These things also say that without the preservation of information, time travel won't happen, because to be in the certain timeline information will also have to change its state in order for a particular person to remember the things and experiences. Basically, information preservation affects the past, present, and future, to happen in a perfect manner because if not, then various paradoxes may happen. This concept not only challenges the traditional view of black holes but also opens up new avenues for understanding the fundamental nature of space-time and the universe itself.

2. Hypothesis

We hypothesize that black holes act as portals between different dimensions, specifically connecting our familiar three-dimensional space to higher-dimensional spaces. When an object crosses the event horizon, it undergoes a transformation that preserves its information in a new form, consistent with the principles of quantum mechanics, but within a different dimensional framework. This preservation occurs through a dimensional shift, where the information is not lost but rather encoded in a higher-dimensional space.

The event horizon, in this context, is more than just a point of no return, it is a boundary between dimensions. As objects cross this boundary, they are subject to a transformation dictated by the nature of the higher dimension they enter. This transformation may involve changes in the properties or states of the particles, ensuring that the information is preserved even if it is no longer accessible in the original three-dimensional space.

This hypothesis draws inspiration from higher-dimensional theories in physics, such as string theory and M-theory, which propose that our universe may contain more than the three spatial dimensions we observe. By extending these ideas, we propose that black holes serve as gateways to these higher dimensions, offering a potential resolution to the information paradox and new insights into the structure of the universe.

3. Theoretical background

To understand the hypothesis that black holes might function as dimensional portals, we must first review the foundational concepts in black hole physics, including the event horizon, singularity, and the information paradox. Additionally, we will explore the theoretical basis for dimensional portals within the context of higher-dimensional physics.

3.1. Event horizon

The event horizon is the defining boundary of a black hole, beyond which no information or matter can escape. For a non-rotating black hole, this boundary is determined by the Schwarzschild radius, r s r s

Which is given by:

$r_s = 2GM \div c^2$

Where

G is the gravitational constant,

M is the mass of the black hole, and

C is the speed of light. The event horizon represents the limit where the escape velocity equals the speed of light, rendering it impossible for any object or information to escape once crossed. In the classical view, crossing this boundary results in the complete loss of information, a notion that is directly challenged by quantum mechanics.

3.2. Singularity

At the center of a black hole lies a singularity, a point of infinite density where space-time curvature becomes infinite. The singularity represents a breakdown of our current understanding of physics, where the laws of general relativity can no longer be applied. The existence of the singularity poses a significant challenge to physicists, as it suggests that the fabric of space-time itself is torn apart, leading to the apparent destruction of any information that reaches this point.

3.3. Information paradox

The information paradox emerges from the conflict between general relativity and quantum mechanics. According to general relativity, information that crosses the event horizon is lost forever, eventually reaching the singularity. However, quantum mechanics posits that information cannot be destroyed. This discrepancy has led to a profound conundrum in theoretical physics, prompting various hypotheses and models attempting to resolve the paradox. Among these is the holographic principle, which suggests that all the information contained within a black hole is encoded on its event horizon, potentially preserving it in a two-dimensional form.

3.4. Dimensional portals and theoretical basis

The hypothesis that black holes could act as dimensional portals is inspired by theories in higher-dimensional physics, particularly those proposed by string theory and M-theory. These theories suggest that our universe may have additional spatial dimensions beyond the three we experience. In this context, black holes might serve as gateways to these hidden dimensions, where the information that crosses the event horizon is preserved in a transformed state.

The concept of extra dimensions has been explored in various theoretical frameworks, most notably through the AdS/CFT correspondence. This correspondence, rooted in string theory, proposes a duality between a gravitational system in a higher-dimensional space (Anti-de Sitter space) and a conformal field theory defined on the boundary of this space. This duality implies that a black hole in a higher-dimensional space could be described by a lower-dimensional field theory, suggesting that the information within the black hole might be preserved in a higher-dimensional form.

By extending these ideas, our hypothesis posits that black holes do not simply trap information but rather facilitate its transition to a higher dimension. In this new dimensional space, the information is preserved in a different form, potentially providing a solution to the information paradox.

4. Mathematical model

To support the hypothesis that black holes function as dimensional portals, we develop a mathematical model that describes the transformation of information as it crosses the event horizon and enters another dimension.

4.1. Information content and entropy

In classical thermodynamics, entropy (S)

Represents the amount of information needed to describe a system's microscopic state. For a system with a set of possible microstates, the entropy is given by:

$S = -k_b \sum_i p_i \log(p_i)$

Where

p_i

Represents the probability of the system being in the

i-th state, and k_b

is the Boltzmann constant. However, in the context of our hypothesis, we introduce a new variable,

I

Representing the information content of a particle before it crosses the event horizon:

$I_{before} = \sum_i p_i \log(p_i)$

This equation captures the information content of a particle in our three-dimensional space.

4.2. Teleportation function

We define a teleportation function

$T(D)$

Where
D represents the dimension into which the information is transported. The information content after crossing the event horizon and entering a new dimension can be expressed as:

$I_{after} = T(D, I_{before})$

The function

$T(D, I_{before})$

Represents the transformation of information as it transitions from our three-dimensional universe into a different dimension. This transformation could involve a change in the state or properties of the information, depending on the characteristics of the new dimension.

4.3. Example of teleportation function

As a simple example, consider a scenario where the information content remains constant, but its state is transformed by a factor

$f(D)$

As it transitions into the new dimension:

$I_{after} = I_{before} \times f(D)$

Here, f(D) could be a factor that scales or modifies the information content based on the characteristics of the new dimension.

4.4. Event horizon as a boundary

The event horizon plays a crucial role in this model, serving as the boundary between our universe and the higher-dimensional space. The Schwarzschild radius.

r_s

Is given by:

$r_s = 2GM \div c^2$

This boundary is where the transformation of information occurs as the particle crosses into another dimension. The information content before and after crossing the event horizon can be related by a function

$f(r_s, D)$

Representing the effect of crossing the boundary:

$I_{before} \cdot f(r_s, D) = I_{after}$

4.5. Combining concepts

By combining these concepts, we can derive a formula that describes how information is preserved and transformed as it crosses the event horizon and enters another dimension:

$I_{after} = \left(\sum_i p_i \log(p_i) \right) \cdot f(r_s, D)$

This formula suggests that the information content after crossing the event horizon is a product of the original information content and a function -

$f(r_s, D)$

That represents the transformation due to crossing into another dimension.

4.6. Example function for

$f(r_s, D)$

Could be defined as:

$f(r_s, D) = 1 + \alpha \cdot \exp(-r_s \lambda_D)$

Where

α α and λ_D

Are constants that depend on the nature of the dimension into which the information is transported. This function could represent how the effect of crossing the event horizon diminishes as the Schwarzschild radius increases or as the dimensional characteristics vary.

5. Implications of the hypothesis

The hypothesis that black holes act as dimensional portals, preserving information in a higher-dimensional space, has several profound implications for our understanding of the universe, the nature of black holes, and the resolution of the information paradox.

5.1. Resolution of the information paradox

One of the most significant implications of this hypothesis is its potential to resolve the information paradox. By suggesting that information is not lost but rather preserved in a different dimensional space, this hypothesis aligns with the principles of quantum mechanics, which demand that information cannot be destroyed. The preservation of information in a higher-dimensional form offers a possible reconciliation between general relativity and quantum mechanics, two of the most fundamental yet seemingly incompatible theories in physics.

5.2. Insights into higher dimensions

If black holes do indeed function as portals to higher dimensions, this could provide empirical evidence for the existence of these additional dimensions, which have long been postulated by theories such as string theory and M-theory. Observations of black holes could then offer indirect evidence of these higher dimensions, helping to bridge the gap between theoretical predictions and observable phenomena.
Moreover, understanding how information is preserved and transformed in these higher dimensions could offer new insights into the nature of space-time and the universe itself. It could lead to a deeper understanding of how the fabric of space-time behaves under extreme conditions and how the universe's multidimensional structure influences the behavior of matter and energy.

5.3. Impact on black hole thermodynamics

The hypothesis could also have implications for black hole thermodynamics, particularly concerning Hawking radiation and the entropy of black holes. If information is preserved in a higher-dimensional space, this could affect the way we understand black hole entropy and the process of Hawking radiation. The entropy of a black hole, traditionally understood through the Bekenstein Hawking entropy formula, might need to be reinterpreted in the context of information preservation across dimensions.

5.4. Potential for new physics

By challenging the traditional view of black holes and proposing that they serve as gateways to higher dimensions, this hypothesis could pave the way for new physics beyond our current understanding. It could inspire new theoretical models that incorporate the role of black holes as dimensional portals, leading to a deeper exploration of the relationship between gravity, quantum mechanics, and higher-dimensional spaces.

6. Potential observational tests

While the hypothesis is speculative, it offers avenues for potential observational tests that could lend support to the idea of black holes as dimensional portals. These tests could involve studying the behavior of matter and energy near the event horizon, as well as analyzing the properties of Hawking radiation and black hole entropy in light of the proposed information preservation mechanism.
Gravitational Waves: Studying gravitational waves from black hole mergers could reveal deviations that suggest the presence of additional dimensions.
Hawking Radiation and Black Hole Evaporation: Observing the properties of Hawking radiation could provide clues about the preservation of information in higher dimensions.
Black Hole Entropy: Precise measurements of black hole entropy could reveal deviations that support the hypothesis.
Here's a briefly explained version of the Observational Tests

6.1. Gravitational waves

The detection of gravitational waves from black hole mergers offers a unique opportunity to study the properties of black holes and their event horizons. If black holes are indeed connected to higher dimensions, this might manifest in subtle deviations from the predicted waveforms of gravitational waves. These deviations could provide indirect evidence for the presence of additional dimensions and the role of black holes as portals.

6.2. Hawking radiation and black hole evaporation

Observing the properties of Hawking radiation could also provide clues about the nature of black holes and the preservation of information. If information is preserved in a higher-dimensional space, this might influence the spectrum or distribution of Hawking radiation emitted by a black hole. Advanced observations of black hole evaporation could reveal anomalies that support the idea of information preservation in higher dimensions.

6.3. Observational tests of black hole entropy

The entropy of a black hole, as described by the Bekenstein Hawking formula, might also provide insights into the proposed hypothesis. If information is preserved in a higher-dimensional space, the relationship between a black hole's entropy and its event horizon area could be affected. This could lead to deviations from the expected entropy values, which might be detectable through precise measurements and comparisons with theoretical predictions.

6.4. Simulations of black hole dynamics

Advancements in computational physics allow for simulations of black hole dynamics under various theoretical frameworks. By creating models that incorporate the hypothesis of dimensional portals, researchers can simulate the behavior of matter and information as it interacts with black holes. These simulations could reveal novel predictions about the interaction of particles crossing the event horizon, which can then be compared with current observational data from black hole studies.

7. Conclusion

The hypothesis that black holes act as dimensional portals, preserving information by transporting it into higher dimensions, offers a novel perspective on one of the most profound mysteries in modern physics: the information paradox. By proposing that black holes serve as gateways to higher dimensions, where information is transformed and preserved, this hypothesis seeks to reconcile the principles of quantum mechanics with the predictions of general relativity.
This hypothesis, while speculative, opens up exciting possibilities for new physics and deeper understanding of the universe's fundamental structure. It challenges our current understanding of black holes, suggesting that they are not just cosmic end points but rather dynamic entities that connect different dimensions of space-time.
Future research, both theoretical and observational, will be crucial in exploring this hypothesis further. Whether through the study of gravitational waves, Hawking radiation, or black hole thermodynamics, the potential to uncover new insights into the nature of black holes and the fabric of the universe is vast. If confirmed, this hypothesis could represent a significant step forward in our quest to understand the true nature of reality.
This draft provides a more comprehensive explanation of the hypothesis, introducing new mathematical models, exploring the implications of the hypothesis, and suggesting potential observational tests. The goal is to create a manuscript that not only proposes a novel idea but also connects it to existing theoretical frameworks and suggests pathways for future research.

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I hope this contribution to the field of astrophysics will inspire further exploration and discussion among my peers.

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