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# The Black Hole Information Paradox: Is Omniscience a Fundamental Property of the Universe?

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***Abstract***

*We seek to examine the ontological aspects of the resolution of the black hole information paradox. Several concepts which are now central to our understanding of quantum mechanics arose from our resolution to this paradox, and these concepts point to the conservation of all information, even on a quantum level. If quantum information is conserved and can never be erased or destroyed, then this indicates that all information is at least theoretically, ultimately retrievable and knowable from the event horizon of the universe. Ontologically, this supports the contention that a repository of all information in the universe must therefore exist. Herein, we trace the steps in this contention and conclude with the argument that our understanding of the universe points to the existence of an omniscient entity.*

***Keywords:*** *Saving Literacy, Ability to Repay Debt. Knowledge Transfer, PLS-SEM*

## INTRODUCTION

There are several, important background bodies of work that are components of our analysis. Initially, we will describe the black hole information paradox and why it is significant to an understanding of the conservation of information in our universe. Second, we will describe how this paradox was resolved, and how this resolution confirms that information is conserved (e.g. information can never be erased). Third, we will describe how this means that all the information in the universe is ultimately knowable, and therefore, that an omniscient entity or repository of all the information in the universe likely exists. In this analysis, we will address the ontological argument that, if all information in the universe is conserved, then this points to the implication that an omniscient entity can and should exist.

The significance of the resolution to the black hole information paradox to our understanding of quantum mechanics cannot be overstated. For decades, this was one of the central mysteries in our understanding of black holes. Subsequently, the resolution of this paradox, which spanned several disciplines of physics, including quantum mechanics and string theory, led to one of the most important revelations in our understanding of the universe.

### Background of the Black Hole Information Paradox

The law of conservation of information has long been hypothesized to be an important and central idea of how the universe works. Landauer asserted that information must be a physical feature of systems, and therefore, that it must be subject to the basic laws of physics that govern reality. For this reason, information can never be erased, but can only be rearranged (non-destructively) into more complex forms, where data appears to be more hidden.1 This has since been recognized as such a fundamental law of physics, that string theorist Leonard Susskind dubbed it as the "minus one" law of thermodynamics, since it is so fundamental (even more so than the 0th law of thermodynamics). As a result of our understanding of the law of conservation of information, we would expect that data could be rendered into a more complex form and may be computationally difficult to disaggregate from the surrounding environment, but data and information can never be erased.2

Stephen Hawking rose to prominence and was recognized to be the world's leading authority on black hole physics.3 Black holes are important, because they test the boundaries of our understanding of reality, by presenting us with a setting where the laws of physics are stretched by the extreme conditions that black holes

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pose.4,5 One of Stephen Hawking's important initial contributions to our understanding of black holes was noting that black holes seem to have the capacity to erase information from reality. This was a major test for the proposed law of conservation of information.

Initially, when an entity falls into a black hole, its information seems to become inaccessible to the outside universe. Indeed, the event horizon of a black hole seems to function like a "firewall", which prevents the transfer of data between any two observers who are on opposite sides of the black hole event horizon.6 This understanding arose in part from the "no hair theorem", which asserts that black holes can be entirely explained and understood by their mass, charge, and spin, and not their internal contents or other quantum states or information.7,8

Subsequently, over long timescales, black holes eventually evaporate. Evaporation occurs through a mechanism of production of quantum pairs at the event horizon, which occurs spontaneously. One particle of the pair would necessarily always fall into the event horizon. The other particle would be released back into the universe.9 This results eventually in a gradual decrease in the mass of the black hole, since the energy released from the black hole in the form of radiation must come at the expense of the black hole's mass.10 That evaporation, dubbed as "Hawking radiation", seemed initially to only depend on the charge, spin, and mass of the black hole. Therefore, this radiation seemed to erase the contents of the black hole and seemed to preclude the possibility that information about those contents could be known.11

So, black holes, seemed to have two separate chances to violate the conservation of information, and seemed to act as "quantum erasers" of data, eliminating information and data from the universe.12 This seemed to indicate, by Stephen Hawking's arguments, that black holes were capable of violating the law of conservation of information, and that this law was therefore, disproven.

## Resolution of the black hole information paradox

Consensus has emerged that, despite this initial interpretation, black holes are incapable of erasing information from the universe.13-15 Quantum information cannot be deleted or hidden from reality.16 In addition to the theoretical consensus, this argument has been verified in our experimental studies of quantum computers, which have shown that data that is "deleted" from a quantum bit (q-bit) can be retrieved from the environment.17

Cheifly, Gerard 't Hooft proposed a way to resolve the apparent contradictions between Hawking's assertion that black holes delete information, and the theoretical and experimental observation that quantum information cannot be hidden or deleted. 't Hooft's mechanism suggested that the information within the volume of space in a black hole's event horizon can be represented by data on the lower dimensional surface of the event horizon. Therefore, the data that exists on the surface of the black hole is an imprint of the information absorbed by the black hole. The surface of the black hole's event horizon preserves information about the contents of the black hole. Deformations of the texture of the black hole's event horizon can influence the Hawking radiation that leaves the black hole, since the Hawking radiation emerges from the precise boundary of the black hole's event horizon.18-21

It's worth pausing to further consider the implications of 't Hooft's model. If you consider a three-dimensional space, such as a sphere or a ball, the amount of data that can be held by that space ought to be proportional to how many volume elements (defined as voxels) are within the space.22 However, 't Hooft's model showed that the amount of data is instead proportional to the area on the surface of the space. To analogize this model, we can represent the data within the volume of a space by only considering the outer surface of that space, like mapping the data within a library by the outer contour of the library building itself.2,23,24 This seems counterintuitive to our understanding of space itself, since one would be inclined to think that a volume of space can hold data proportional to the three-dimensional volume of that space, rather than the two-dimensional surface area of that volume.

Some of the mathematics of this model are complicated and beyond the scope of this manuscript. In brief, this is a holographic model of the universe, because all the information about a three-dimensional space can be provided by considering the lower dimensional outer surface of that space.2,25,26 A negatively curved three-dimensional space (anti-de Sitter space or AdS space) can give rise to gravity and other forces as emergent properties.27 So briefly, this feature of the holographic model also gives us the advantage of an explanation for gravity as an emergent property.

Conformal field theory (CFT) as a description of a space gives us a way of using a scalar property to essentially describe an additional spatial dimension and other properties, as long as the pixels on the surface area of that space are conformal.28 AdS-CFT correspondence is a nice framework for representing reality, because it provides a way for the simpler mathematics and physics at the surface of a three-dimensional space to explain the observed reality within that space.29

The mathematics of the holographic model of information that represents the volume of a black hole, including the lower dimensional matrix of the event horizon was resolved by Leonard Susskind (along with 't Hooft), using string theory. Susskind used string theory to explain the contour of the event horizon of the black hole, and how that information could be "stored" on the surface of the black hole by the event horizon's contour.21,30 Susskind's analysis provided a holographic model using string theory and the AdS-CFT correspondence to explain, based on 't Hooft's contentions, how the black hole event horizon could be a lower dimensional representation of the quantum information within the black hole. The physics that govern this representation apply not only to the black hole's event horizon, but also to the event horizon of the universe.30,31

Susskind's analysis of the universe as a hologram has given rise to several metaphysical and philosophical debates.26 The resolution of the black hole information paradox proved that the law of conservation of information is obeyed at the quantum level, even in the most extreme settings of the universe.2 This leads to the conclusion that the information about the universe is always at least theoretically knowable. Even as information becomes more chaotic and complex over time, that information is never destroyed. This makes the existence of an omniscient entity at least possible. Conceivably, an omniscient entity looking at the surface of the universe, would have all knowledge of all the information on the inside of the universe, as well as the history of that information.

Information defines and delineates reality, so if there is a lower dimensional representation of the data of our reality, then that representation is as real as our universe.32 If we reconcile the mechanism of how a hologram functions, then the lower dimensional representation is likely the origin of the information that appears to be "within" the universe, and that lower dimensional representation is the source of the reality that we experience.33

It's important to note that observers within the universe would never have this vantage point, since any observer within the universe can only interact with entities within their light cone. So, the analysis of the conservation of information at the event horizon of the universe is only applicable to entities outside of that event horizon, by definition.34

Ultimately, the resolution of the black hole information paradox proved that information cannot be deleted from reality. All the information contained within the universe is theoretically knowable through observation of the event horizon of the universe.

## Philosophical and Ontological Implications of the Holographic Universe

The fact that data and information are the source of our reality enables us to conclude that at least on a theoretical basis, omniscience is possible. Data and information cannot be erased, and the process of rearranging information in the timeline of the universe is non-destructive, meaning that every instant throughout space and time is ultimately knowable and fixed on the event horizon of our reality. None of that information can be destroyed, and all of it is conceivably retrievable. Mathematically, the lower dimensional representation of data in the universe would be simpler than our three-dimensional subjective experience of that data.

Many thinkers have advanced that if something can exist, then it must exist. This suggests that in addition to endorsing the theoretical possibility of omniscience, the holographic universe must also mean that an omniscient entity does exist.35

The idea that anything that can exist must exist is known as the "principle of plenitude".36 Various philosophers have argued that, particularly given a multiverse of possibility, if we can conceive of something that exists, then it ought to exist in actuality.35 It should be noted that this is a philosophical idea and not an empirically proven statement. So, at this point, the theoretical possibility of omniscience points toward, but does not definitely prove that omniscience exists. Murray Gell-Mann invoked a similar totalitarian principle (everything that is possible is compulsory) in his model of elementary particles, which was an important step in understanding quark interactions, although this work preceded our understanding of the black hole information paradox by several decades.37

The principle of plenitude has been previously invoked as an argument that God must, necessarily, exist.38 However, our analysis is more focused and instead suggests that a specific feature of God is at least theoretically possible, since all information is theoretically knowable.

Other frameworks, also point to the fact that the presence of information implies the existence of consciousness. This idea has been advanced by John Wheeler.39 Using this analysis, the presence of information, represented on the event horizon of the universe, implies that a conscious entity is present to absorb this information. Because a conscious entity outside of the universe would be time-invariant, it would be perceived to be omni-temporal. So, an omniscient entity beyond our universe should exist throughout what we perceive as the entire duration of the universe. Because time and space are united in a single framework of Minkowski space-time, such an omniscient, omni-temporal entity would also necessarily be omni-present.40

## DISCUSSION

Herein, we have sought to explain a brief summary of the black hole theory war and describe how this debate resolved one of the most fascinating paradoxes regarding quantum information. The resolution of this debate supports the law of conservation of information. The assertion that information can never be destroyed, and that information is preserved on the event horizon of reality, is now a part of the scientific consensus.

There are of course, many other facets that would be required for omniscience to ensue. Information would have to be accessible and interpretable. There would also need to be a way of disaggregating the information on the event horizon of the universe. However, as we have described, the complete makeup of reality is theoretically knowable, which mitigates at least one of the arguments against the possibility of an omniscient entity.

Other writers have considered several other interesting implications of the holographic universe. For example, David Bohm considered that one of the properties of holograms is self-similarity. Therefore, a smaller entity within a reality might convey information about a larger construct. Bohm analogized a holographic model of the brain to a holographic universe.41 This carries implications regarding the idea that humans are created in God's image. This is an interesting outcome of a holographic model of the universe but is beyond the scope of what we have considered.

The implications of the holographic universe in regard to information science have also been considered by others.42 Some have argued that some of the features of a holographic universe, which suggest that reality is indeed simulated, are consistent with the contention that the universe has been created.43

To our knowledge, this manuscript is the first publication that asserts that omniscience is at least theoretically possible, based on the law of conservation of information, as understood through the lens of the resolution of the black hole information paradox.

Our analysis also has the implication that other attributes of an omniscient entity beyond the event horizon of the universe would be emergent from the paradigm of omniscience that we have delineated. As we have described, omni-presence and omni-temporality would be emergent features from the model of omniscience that we have offered.

## CONCLUSION

In short, we have discussed the history of the ideas around conservation of information. We have shown that the resolution of the black hole information paradox supports the modern consensus that information must be governed by the laws of physics, and therefore, information can never be destroyed. The holographic model as a resolution of the black hole information paradox suggests that all information about the universe is knowable, and that this information becomes very complex over time, but can never be erased. It also suggests that information is represented in a lower-dimensional, and therefore less complex format, at the event horizon of the universe. Our model of omniscience also carries with it the attributes of omni-presence and omni-temporality. The holographic universe has many fascinating implications, but one of those implications is that all the information about the universe can be known. This indicates that omniscience is at least a theoretical possibility.

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