

The Basis for White Hole formation

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Abstract

The understanding of how a white hole is formed, and the confusion between the many theories/hypothesis has created a blurry picture. This review will cover the factors required for white hole formation and the theory concerning the death of a black hole to form a white hole. The link to general relativity and the future aspects will also be covered.

1. Introduction

A white hole is a hypothetical region of space-time that cannot be entered from the outside, although matter and light can escape from it. It is believed that white holes can solve the black hole information paradox and many issues in quantum mechanics. ?] It is described as the exact opposite of black holes as it gives out matter at enormous speeds. These white holes are only based on theoretical conclusions and on Einstein's theory of general relativity and may not exist in reality. ?] White holes and black holes possess the same mathematical and geometrical structures as each other, so they are theoretically just opposites of each other (In function). A white hole just like a black hole has an event horizon from which all matter comes out. It is believed that white holes sum up most of the questions related to the black hole and could also play a big role in the big bang. Black holes emit radiation known as Hawking radiation, which makes them lose their mass.

This review will discuss the different theories/assumptions put forward on the understanding of the existence of white holes and their link with black holes. The many hypothesis put forward to understand white holes all have their ideologies and it is important to understand all of these ideologies to pursue further research related to white holes. Research earlier has suggested that all of the matter and light falling into a black hole escapes from the white hole. It could escape into the same cosmos or a completely different universe. Although Carlo Rovelli and his team of theoretical physics suggested that when black holes die they become white holes. The fact that a dead black hole is a white hole clearly objectifies the statement that all matter that enters a black hole exits the white hole in a different universe.

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2. Rovelli's Theory

It is believed that a black hole releases Hawking radiation throughout the course of its existence and simultaneously also continues to shrink. It shrinks until it reaches the Planck constant radius.

As a black hole continues to die/shrink it does not just 'disappear': it tunnels into a white hole (from the outside, an object very similar to a black hole), which can then leak out the matter trapped inside [?]. The likely end of a black hole is therefore not to suddenly pop out of existence, but to tunnel to a white hole, which can then slowly emit whatever is inside and disappear, possibly only after a long time. The Einstein equations are ignored for a slight period of time, for the quantum gravitation effects on black holes to be studied. The possibility for tunneling is very small for a giant black hole although as it continues to evaporate the possibility for it to tunnel increases. This is because its mass decreases (affirmed from the standard tunneling factor). As the black hole shrinks towards the end of its evaporation, the probability to tunnel into a white hole is no longer suppressed. The transition gives rise to a long-lived white hole with Planck size horizon and very large but finite interior [?].

The 2 scientists theoretically prove that standard black hole evaporation followed by a transition to a Planck-mass white hole (While satisfying the fixed and required conditions). This result shows that this scenario is consistent with known physics and does not violate unitarity.

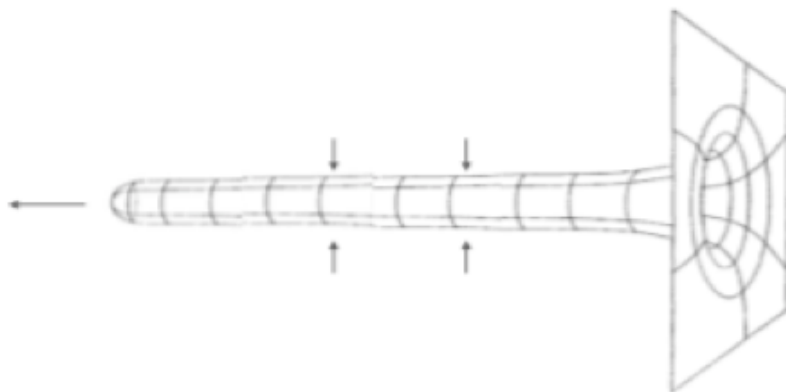


Figure 1: The interior geometry of an old black hole: a very long thin tube, whose length increases and whose radius decreases with time.

3. Structure and Formation of a White hole

An assumption is that the Hawking process proceeds beyond the Planck curvature at the horizon and pinches off the large interior of the black hole from the rest of space-time. [?] This assumption uses quantum field theory on curved space-time beyond its regime of

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validity. Without a physical mechanism for the pinching off, this scenario is unrealistic. The diagram for this scenario is shown in the figure below.

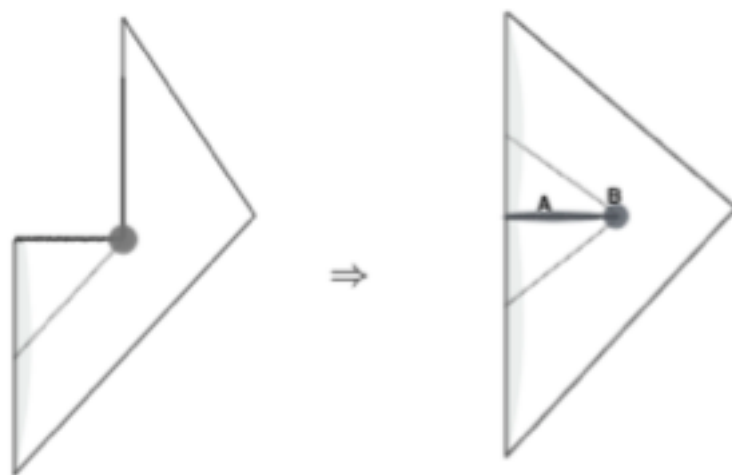


Figure 2: Left: A commonly drawn diagram for black hole evaporation. Right: A black to white hole transition. The dashed lines are the horizons.

The important point is that there are two regions inside horizons: one below and one above the central singularity. That is, the black hole does not simply pop out of existence: it tunnels into a region that is screened inside an (anti-trapping) horizon. Since it is anti-trapped, this region is actually the interior of a white hole. Thus, black holes die by tunneling into white holes.

The white hole- despite having a very small (plank sized event) horizon, has a very large interior volume and this is because it is inherited from the black hole that generated it.

Continuity of the size of the tube in the transition across the singularity, results in a white hole formed by the bounce, which initially also consists of a very long interior tube, as in Figure 3. Subsequent evolution short- ens it (because the time evolution of a white hole is the time reversal of that of a black hole), but this process can take a long time Rovelli . Remarkably, this process results in a white hole that has all Planckian mass and a long life determined by how old the parent black hole was. In other words, the outcome of the end of a black hole evaporation is a long-lived remnant.

4. Einstein's Theory of General Relativity

White holes are predicted as part of a solution to the Einstein field equations known as the maximally extended version of the Schwarzschild metric describing an eternal black hole with no charge and no rotation. White holes are said to connect the matter entering a black hole into a completely different universe. Tunneling from black holes to white holes solves Einstein's equations of general relativity and white holes in particular are the solution.

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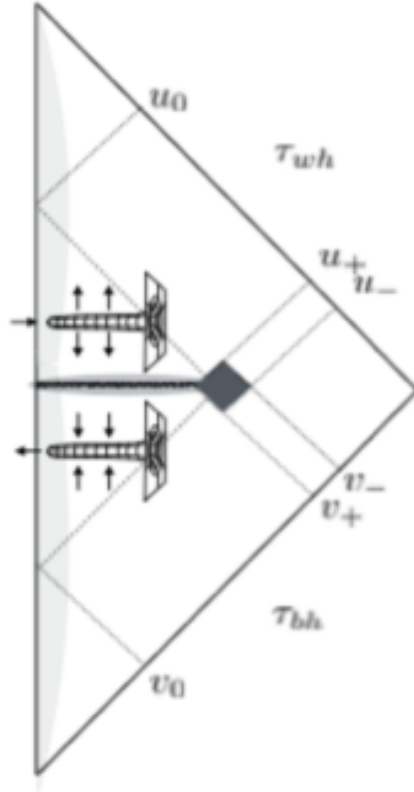


Figure 1: Black hole bounce, with a sketch of the inside geometries, before and after the quantum-gravitational transition.

5. The Big Bang from a White Hole

There is also a hypothesis that our universe is created from a white hole burst which dies after releasing all matter. The universe is believed to be born in a sudden moment. Before this event happens, the white hole has no definite coordinates in space-time, and thus no gravitational effect on the environment of its destined eruption location [?]. Instead, like the birth of the universe itself, this process should be sudden, unpredicted and a single occasion event which happens in a short frame of time. Note that the best way to avoid the expected death of white holes is to eject all matter at a single instance. They claim that white holes cannot be continuously observed as black holes. They can only be detected soon after they show up. The hypothesis states that the white hole is only a short window, through which material / energy is spilled out once. When a large amount of mass is ejected, the gravitational force, which is being expressed through mass, may eventually lead to a collapse and to the formation of a black hole. This is opposes Rovelli's theory that a black hole turns into a white hole cause in this case a dead white hole turns into a white hole. The may also be a possibility for a cyclic chain of death and formation of astronomical matter.

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6. Conclusion

In conclusion, the theory that a black hole evaporates in the process of releasing hawking radiation, sums up the fact that black holes die to form white holes. Due to quantum bounce and a very strong gravitational force the Planck sized horizon black hole turns into a white hole. Although the horizon is Planck sized the interior volume of the astronomical structure (black hole/ white hole) is massive. Due to all of the force, the compressed matter is released with enormous energy. Einsteins theory of general relativity can be soled by white holes but as of now white holes are completely theoretical.

The possibility for the big bang to be in the form of a white hole is also discussed. In this case the white hole would not have any specific location and it would all of a sudden burst out to create a universe. Although this does disprove the fact that a black hole dies to form a white hole, but there is a possibility for a cyclic chain of formations.

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