An exposition on wormholes: Traveling through SPACE-TIME

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Abstract - A walk-through on bending space-time, black holes and white holes, portals in space, and more. This paper majorly focuses on theories, perspectives, and hypothetical situations.

1: INTRODUCING WORMHOLES

Wormholes are tunnel-like structures, comparable to space bridges that connect two distant sections of the universe and allow us to travel at even the speed of light.

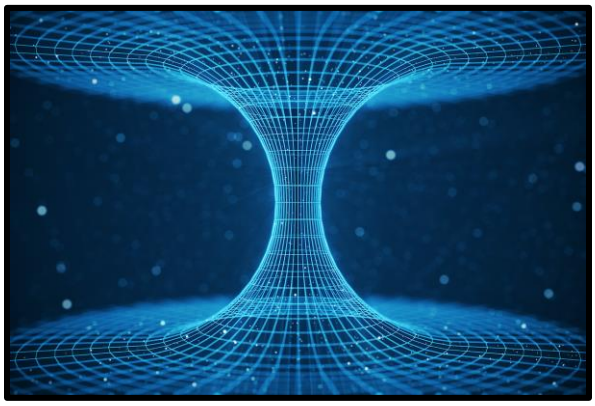

Figure 1

Essentially, it's a theory of gravity. The underlying assumption is that gravity is a bending or warping of space rather than an unseen force that draws objects to one another. The more massive an item is, the more space around it warps. Einstein's theory of relativity suggests that wormholes could exist.

Wormholes were initially proposed in 1916, albeit they were not termed such at the time. While looking through another scientist's solution to the equations in Albert Einstein's theory of general relativity, Austrian physicist Ludwig Flamm recognized there was another way. A "white hole," he said, is a possible temporal reversal of a black hole. Entrances to both black and white holes could be connected by a space-time conduit.

In 1935, Einstein and scientist Nathan Rosen elaborated on the notion, utilizing general relativity theory to propose the existence of "bridges" between space and time. These bridges connect two points in space-time, theoretically creating a shortcut that might halve travel time and distance. The shortcuts were dubbed Einstein-Rosen bridges or wormholes.

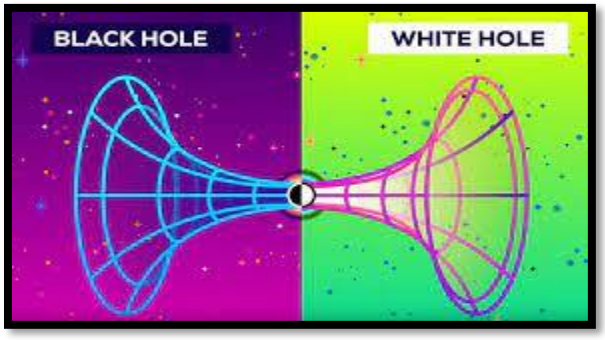

Figure 2

To picture it, a wormhole could be the result of the collision of a black hole and white hole, as we can see that one opening sucks in the matter, while another throws it out, but that wouldn't be an accurate definition for it, due to the actual situation of the merge resulting in the black hole absorbing the white hole inside itself, simultaneously growing in size.

2: THE TYPES OF WORMHOLES

Type 1: Schwarzschild wormholes

The first type of wormhole solution discovered was the Schwarzschild wormhole, which would be present in the Schwarz child metric describing an eternal black hole, but it was found that it would collapse too quickly for anything to cross from one end to the other.

TYPE 2: Einstein-Rosen bridges

Every black hole, according to this hypothesis, is a doorway to an infinite parallel universe. The implicit premise is that gravity is a bending or warping of space rather than an unseen force that attracts objects to one another. The more massive an object, the more it warps the space around it.

The event horizon forms, allowing everything to enter but nothing to leave, trapping everything at its center eternally. The matter is pulled into the black hole in our reality, but it is spat out via the white hole in the parallel universe. Unfortunately, it is impossible to travel through this kind of wormhole, due to the infinite amount of time taken and its property of crimping shut and cutting the passageway.

TYPE 3: Traversable wormholes

These kinds of wormholes are linked to the string theory. If the string theory is right, then following the big bang, quantum fluctuations might have caused numerous holes in the cosmos. These holes would have cosmic threads connecting them, and these cosmic strings were dragged light-years apart in the first trillionth of a second after the big bang happened. Gravity acts as a force, squeezing the bridge closed, but in these traversable wormholes, the cosmic string prevents this from occurring.

Without the string theory, however, traversable wormholes were thought to only be possible only if exotic matter with negative energy density could be used to stabilize them. Physicists later revealed that tiny traversable wormholes may be achievable without the use of exotic matter, needing just electrically charged fermionic matter with a mass small enough to avoid collapsing into a charged black hole.

TYPE 4: Non-traversable wormholes

These are wormholes that nothing can pass through, either because the wormhole collapses; it only has an entry point, but no exit; or the person or particle entering it would be destroyed before reaching the other side.

TYPE 5: Intra-universe wormholes

These are wormholes that link areas and can travel through the same universe.

TYPE 6: Inter-universe wormholes

This type of wormhole can connect our universe to another parallel one.

TYPE 7: One-way wormholes

These wormholes indicate that you can travel only in one direction through them, and need a separate wormhole for the return.

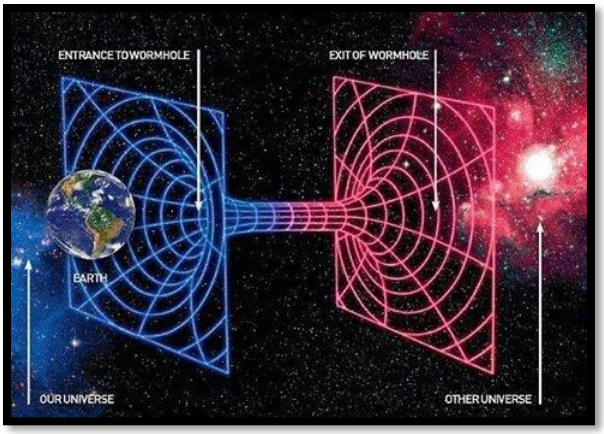

Figure 3

TYPE 8: Two-way wormholes

These wormholes are bi-directional and don't have a specific direction of motion.

3: WHAT A WORMHOLE CONSISTS OF

Wormholes contain two mouths, with a throat connecting the two, according to an article published in the Journal of High Energy Physics (2020). The mouths would most likely be spheroidal, and inside the throat is called a hyperspace.

4: NEGATIVE MASS

The only way to keep a wormhole from collapsing immediately is to fill it with negative energy. Positive energy will not do, because in general relativity energy equals mass, and hence more gravity, which would close up the wormhole. Negative energy is permitted by quantum theory, and its effects have been observed in the laboratory.

It's thought that the Casimir effect, a quantum process in which long-wavelength vacuum fluctuations are suppressed in a region between conducting surfaces, be used to create this negative energy zone.

However, as far as we know, negative mass matter does not exist. We have no evidence for it, and even if it did exist, it would break several universal principles, including inertia and momentum conservation. A negative-mass ball, for example, would fly backward if kicked. Instead of attracting, if you put a negative-mass item next to a positive-mass object, they would repel each other, moving away from each other to infinity.

Another problem we face is the quantity needed. For example, it has been estimated that to create a wormhole with a diameter one-millionth the size of a proton, wormhole engineers would need negative energy equivalent in magnitude to the energy generated by ten billion suns in one year.

To push spacetime open, the exotic matter (negative mass) must exert an enormous amount of pressure, greater than even the pressure at the center of neutron stars.

Neutron stars are the extremely dense remains of giant stars. Their formation occurs after a supernova explosion. The mass of a neutron star is about million times that of the earth but is compressed to about 25km^2. It is so dense that the mass of all living humans could fit inside 1cm^3 of neutron stars.

5: FOCAL PROS AND CONS OF WORMHOLES

Advantages	Disadvantages
1. Connecting very, very distant places in the universe. 2. Wormholes may link not just two different sections of the universe, but perhaps two entire worlds. 3. Possible time travel 4. Some scientists believe that if one of a wormhole's mouths is manipulated in a precise way, time travel may be possible. 5. Instantaneous transport 6. A wormhole might even cross Einstein's speed constraint, due to its ability of warping space-time.	1. High threat levels 2. There are numerous chances that the wormhole could snap shut, trapping all that is inside it. 3. High radiation 4. Wormholes generate incredibly intense radiation, increasing the chance of developing a health problem. 5. Dangerous contact with exotic matter (negative mass) 6. Energy requirement Exotic matter requires an unusually, extremely high amount of energy to be of use. 7. Disrupts the structure of the Universe Wormholes can cause time travel conundrums and mess with the cosmos' fundamental architecture.

6: Some Important Fact Files

1. Do wormholes really exist?

- As of now, wormholes on exist on paper as a theory in astrophysics provided by Albert Einstein, but there is a possibility that they do exist, somewhere in the universe.

2. Do 2-dimensional wormholes exist?

- Wormhole solutions can exist in 3+1 dimensional space time - they have to do with the topology of the space-time manifold, rather than its dimensionality.

3. **Why aren't wormholes stable?**

- To keep gravity from pinching the wormholes closed, a huge amount of energy is used, and to make a wormhole fit for humans to pass through would require an unimaginable amount of energy. Due to the lack of this energy, wormholes usually collapse easily, causing them to be unstable.

4. What is on the other side of a wormhole?

- What is on the other side of the wormhole depends on the location of its mouth. It could transport you anywhere its mouth is placed, maybe even a parallel universe.

5. Why are wormholes dangerous?

- Wormholes can be dangerous due to them relying on a heavy amount of energy required to keep them open, the possibility of getting lost in the middle of space, and the wormhole suddenly closing shut, trapping all inside it. In addition, the time taken to cross a wormhole is never guaranteed, and depending on the distance and space conditions, the things entering the wormhole might not be what is coming out.

6. Does a wormhole have mass?

- An actual wormhole is deprived of any space or mass

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