Brief concept of Worm hole

Jeet Dutta
Lecturer
Technique Polytechnic Institute, Hooghly, India

Abstract— Like black holes, wormholes arise as valid solutions to the equations of Albert Einstein's General Theory of Relativity, and, like black holes, the phrase was coined (in 1957) by the American physicist John Wheeler. Also like black holes, they have never been observed directly, but they crop up so readily in theory that some physicists are encouraged to think that real counterparts may eventually be found or fabricated. The main aim of this paper is to give an idea about wormholes.

Key words: Worm hole

I. INTRODUCTION

Wormholes are solutions to the Einstein field equations for gravity that act as "tunnels," connecting points in space-time in such a way that the trip between the points through the wormhole could take much less time than the trip through normal space.

The first wormhole-like solutions were found by studying the mathematical solution for black holes. There it was found that the solution lent itself to an extension whose geometric interpretation was that of two copies of the black hole geometry connected by a "throat" (known as an Einstein-Rosen bridge). The throat is a dynamical object attached to the two holes that pinches off extremely quickly into a narrow link between them.

Theorists have since found other wormhole solutions; these solutions connect various types of geometry on either mouth of the wormhole. One amazing aspect of wormholes is that because they can behave as "shortcuts" in space-time, they must allow for backwards time travel! This property goes back to the usual statement that if one could travel faster than light that would imply that we could communicate with the past. Needless to say, this possibility is a disturbing one; time travel would allow for a variety of paradoxical situations, such as going back into the past and killing your grandfather before your father was born (the grandfather paradox). The question now arises of whether it would be possible to actually construct a wormhole and move it around in such a way that it would become a usable time machine.

Wormhole geometries are inherently unstable. The only material that can be used to stabilize them against pinching off is material having negative energy density, at least in some reference frame. No classical matter can do this, but it is possible that quantum fluctuations in various fields might be able to.

Stephen Hawking conjectured that while wormholes might be created, they cannot be used for time travel; even with exotic matter stabilizing the wormhole against its own instabilities, he argued, inserting a particle into it will destabilize it quickly enough to prevent its use. This is known as the Chronology Protection Conjecture. Wormholes are great theoretical fun, and are seemingly valid solutions of the Einstein equations. There is, however, no experimental evidence for them.

II. BRIEF HISTORY

In 1916, the Austrian physicist Ludwig Flamm, while looking over Karl Schwarzschild's solution to Einstein's field equations, which describes a particular form of black hole known as a Schwarzschild black hole, noticed that another solution was also possible, which described a phenomenon which later came to be known as a “white hole”. A white hole is the theoretical time reversal of a black hole and, while a black hole acts as a vacuum, drawing in any matter that crosses the event horizon, a white hole acts as a source that ejects matter from its event horizon. Some have even speculated that there is a white hole on the "other side" of all black holes, where all the matter the black hole sucks up is blown out in some alternative universe, and even that what we think of as the Big Bang might in fact have been the result of just such a phenomenon.

He also noticed that the two solutions, describing two different regions of space-time could be mathematically connected by a kind of space-time conduit, and that, in theory at least, the black hole "entrance" and white hole "exit" could be in totally different parts of the same universe or even in different universes! Einstein himself explored these ideas further in 1935, along with Nathan Rosen, and the two achieved a solution known as an Einstein-Rosen bridge (also known as a Lorentzian wormhole or a Schwarzschild wormhole).

A. Schwarzschild Wormholes

Lorentzian wormholes known as Schwarzschild wormholes or Einstein-Rosen bridges are bridges between areas of space that can be modeled as vacuum solutions to the Einstein field equations by combining models of a black hole and a white hole. This solution was discovered by Albert Einstein and his colleague Nathan Rosen, who first published the result in 1935. However, in 1962 John A. Wheeler and Robert W. Fuller published a paper showing that this type of wormhole is unstable, and that it will pinch off instantly as soon as it forms, preventing even light from making it through.

Before the stability problems of Schwarzschild wormholes were apparent, it was proposed that quasars were white holes forming the ends of wormholes of this type.

While Schwarzschild wormholes are not traversable, their existence inspired Kip Thorne to imagine traversable wormholes created by holding the 'throat' of a Schwarzschild wormhole open with exotic matter (material that has negative mass/energy).

B. Traversable Wormholes

Lorentzian traversable wormholes would allow travel from one part of the universe to another part of that same universe very quickly or would allow travel from one universe to another. The possibility of traversable wormholes in general relativity was first demonstrated by Kip Thorne and his graduate student Mike Morris in a 1988 paper; for this reason, the type of traversable wormhole they proposed, held open by a spherical shell of exotic matter, is referred to as a Morris-Thorne wormhole. Later, other types of traversable wormholes were discovered as allowable solutions to the equations of general relativity, including a variety analyzed in a 1989 paper by Matt Visser, in which a path through the wormhole can be made in which the traversing path does not pass through a region of exotic matter. However in the pure Gauss-Bonnet theory exotic matter is not needed in order for wormholes to exist- they can exist even with no matter. A type held open by negative mass cosmic strings was put forth by Visser in collaboration with Cramer et al., in which it was proposed that such wormholes could have been naturally created in the early universe.

Wormholes connect two points in spacetime, which means that they would in principle allow travel in time, as well as in space. In 1988, Morris, Thorne and Yurtsever worked out explicitly how to convert a wormhole traversing space into one traversing time. However, it has been said a time traversing wormhole cannot take you back to before it was made but this is disputed.

C. Faster-Than-Light Travel:-

Special relativity only applies locally. Wormholes allow superluminal (faster-than-light) travel by ensuring that the speed of light is not exceeded locally at any time. While traveling through a wormhole, subluminal (slower-than-light) speeds are used. If two points are connected by a wormhole, the time taken to traverse it would be less than the time it would take a light beam to make the journey if it took a path through the space outside the wormhole. However, a light beam traveling through the wormhole would always beat the traveler. As an analogy, running around to the opposite side of a mountain at maximum speed may take longer than walking through a tunnel crossing it. You can walk slowly while reaching your destination more quickly because the distance is smaller.

D. Time Travel-

A wormhole could allow time travel. This could be accomplished by accelerating one end of the wormhole to a high velocity relative to the other, and then sometime later bringing it back; relativistic time dilation would result in the accelerated wormhole mouth aging less than the stationary one as seen by an external observer, similar to what is seen in the twin paradox. However, time connects differently through the wormhole than outside it, so that synchronized clocks at each mouth will remain synchronized to someone traveling through the wormhole itself, no matter how the mouths move around. This means that anything which entered the accelerated wormhole mouth would exit the stationary one at a point in time prior to its entry.

It is thought that it may not be possible to convert a wormhole into a time machine in this manner; some analyses using the semi-classical approach to incorporating quantum effects into general relativity indicate that a feedback loop of virtual particles would circulate through the wormhole with ever-increasing intensity, destroying it before any information could be passed through it, in keeping with the chronology protection conjecture. This has been called into question by the suggestion that radiation would disperse after traveling through the wormhole, therefore preventing infinite accumulation. The debate on this matter is described by Kip S. Thorne in the book Black Holes and Time Warps. There is also the Roman ring, which is a configuration of more than one wormhole. This ring seems to allow a closed time loop with stable wormholes when analyzed using semi-classical gravity, although without a full theory of quantum gravity it is uncertain whether the semi-classical approach is reliable in this case.

III. CONCLUSION

So far, physicists haven't determined a way in which wormholes would form naturally in the Universe. However, theoretical physicist John Wheeler said it's possible that wormholes may spontaneously appear and disappear, according to his quantum foam hypothesis (the idea that virtual particles are, quite weirdly, popping in and out of existence at all times).

Unfortunately, Wheeler theorized that these impromptu wormholes would be super small, appearing at the Planck scale. That's about 10-33 centimeters long. In other words, the wormhole would be so small that it'd be almost impossible to detect.

Let's suppose, however, that we could find tiny wormholes as they pop into existence: We might be able to make them bigger. And to do that, you'd need a funky material called exotic matter. Exotic matter is a little bit different. It's matter that has negative energy density and/or negative pressure.

Negative properties of exotic matter might push the sides of a wormhole outward, making it large enough—and stable enough—for a person or a spaceship to fit through it. Except exotic matter isn't exactly easy to come by; it exists only in theory, we don't know what it looks like, and we have yet to know where to find it.

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