

# A Wormhole of Mystery: How Does Kirby Stomach It?

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Kirby, the protagonist of a series of eponymous games, is a small “pink puffball” capable of devouring almost anything in his wake[4]. He uses this “Inhale” ability to both obtain powers from what he swallows or to spit whatever he has inhaled back out as stars which can be used to damage his enemies. There are many perplexing powers in his arsenal, such as his ability to fly by inhaling the air around him, or to copy abilities from his swallowed enemies, but the most fascinating of all is how he can consume a seemingly infinite amount of matter.

Although a simple answer to this question would be the fact that Kirby’s mouth and body can expand to fit whatever he is eating, this cannot apply to situations in which he ingests many times more than his entire body’s volume. A more plausible explanation would be that his mouth is linked to his own “pocket dimension” [2] where he stores everything he inhales, but this comes with its own problems. Firstly, we need a way for his pocket dimension to be connected up to his mouth, as the pocket dimension being inside his stomach would mean that anything he inhales will still fill up his stomach, leading to the same problem of not having enough space within his body. We can get around this by using the concept of wormholes.

Wormholes are a theoretical solution to Einstein’s Field Equations which can bring two pieces of space-time that would conventionally be far apart much closer together, allowing faster than light travel.

The idea stems by moving two points in space-time closer together in a manner similar to folding a sheet of paper such that two points on either end are brought together (as pictured on the right), which happens to be an example of how non-Euclidean geometry can exist in the universe, a stark contrast to how we usually see space-time. This preserves the space-time between the two points that would have needed to be traversed normally as the “folded” piece of the paper (the red arrow), but as those two initially far away points are now touching, there is a second, shorter way to move between the two points (the green arrow). We currently have no proof of the existence of wormholes, but as they have been predicted by Einstein’s Field Equations, we can see that they are a possibility, although it should be noted that, just because something satisfies the mathematics of the universe, it is not necessarily possible in real life. Another major downside to these wormholes is that they would only be stable at a very small scale (in particular the Planck Scale),[7] since the only known natural phenomenon that could cause a traversable wormhole to exist is the “quantum foam” effect.[5] [9] For scale, one Planck length is approximately equal to  $1.616 \cdot 10^{-35}$  metres, or  $1.5 \cdot 10^{-25}$  times the size of a hydrogen atom. At this small scale, pairs of particles and anti-particles are produced at random over very short time periods, and usually they will annihilate almost as soon as they were created, but as is shown in effects such as Hawking radiation, there are situations in which they will not annihilate each other. In Hawking radiation, we see an effect where, at the edge of a black hole’s event horizon, a particle anti-particle pair is produced such that one particle is inside the black hole and the other is outside.[3] As nothing can escape a black hole, the pair can no longer annihilate, as either the particle or anti-particle has been taken away before it could annihilate.

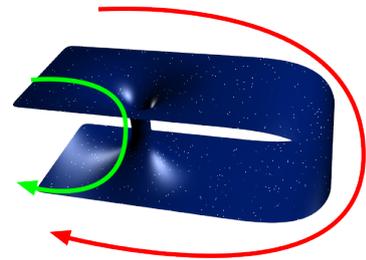


Figure 1: An illustration of a wormhole.[6]

We can use a similar principle to theorise how Kirby’s mouth can remain indefinitely stable while inhaling, as in most instances he can inhale for an unlimited amount of time. The kind of wormhole we need for Kirby, known as a traversable wormhole, is inherently unstable, as gravity will try to close it as soon as it is produced, so we will also need a way to combat gravity and keep them open. This is where a variation of our previous idea of Hawking radiation can come into play. What we need to combat gravity and keep the wormholes open is known as “exotic matter”.[10] Exotic matter is a theoretical type of matter with negative mass (bear in mind that even anti-matter has positive mass), and this is precisely what we need. In our universe, all matter we see has a positive mass, and thus it attracts other matter around it due to gravity and the “bending” of space-time, but exotic matter would “bend” space-time the other way, being repulsive due to gravity. This is best explained through an analogy with a sheet of Lycra: suppose that you put a marble in the centre of this Lycra sheet which is suspended at the edges. This would pull down the Lycra and create a dip around the marble, meaning that if you were to roll another marble nearby, it would bend around the first marble in a very similar effect to how gravity would pull a passing asteroid. What a negative mass would do in this model is push up from the bottom of the Lycra, making a “hill” around it, and so if you were to roll another marble around the top of this

hill, it would slide off and be “repelled” by the repulsive force of gravity the exotic matter exerts.

In the diagram on the right, we can see an illustration of this Lycra experiment, with the exotic matter creating the “hills” on the left that protrude upwards, and normal matter on the right creating “dips” that protrude downwards. With this exotic matter, we can counteract the force of gravity and push outwards on the edges of the wormhole, keeping it open. To produce this exotic matter, we can use the previous principle of pair production to produce this negative mass effect, and send the produced real matter into Kirby’s pocket dimension as it is produced. Note that this will temporarily violate the law of conservation of energy, but due to the convoluted ways in which quantum mechanics operates, it is sometimes necessary to temporarily violate these laws on a small scale.[1] We can also propose that Kirby’s wormhole is a Visser wormhole,[8] which means minimal amounts of exotic matter will need to be used to keep his wormhole open. But now we must confront another problem – how will the produced matter be managed?

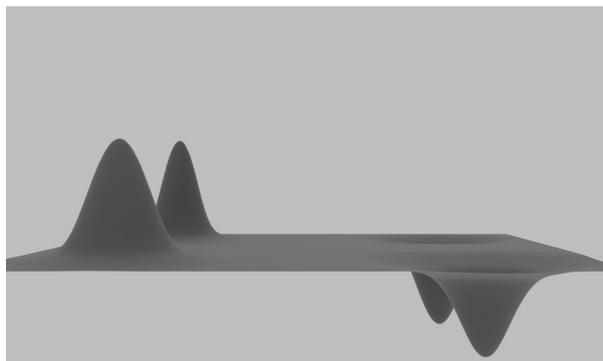


Figure 2: An illustration of the Lycra experiment. Created by Yousif Al-Naimi

As we have previously said, Kirby could shovel the produced matter into the wormhole as well, but all of that produced matter being concentrated into the small space of his mouth (around 20 centimetres in diameter based off the size of his body)[4] would likely cause some issues. The edges of his mouth must have all of the space inside compressed into an extremely small space to form the edge of the wormhole, necessarily meaning that the pressure and temperature would rise significantly. With enough matter in this small space, fusion can start to occur between the atoms in the matter, causing vast amounts of heat and light to be produced while Kirby inhales. This would likely incinerate both Kirby’s mouth and anything he swallows. This is exacerbated by the high pressure difference between the pocket dimension, which resembles empty space, and the full world Kirby is in, which would mean that objects would be sucked into his mouth at extraordinary speed. Even if Kirby could somehow resist the heat, which is potentially plausible given how quickly he recovers from being burned in the games, he could no longer use his copy ability, as any enemy he swallows would be killed by the heat before he could take their ability. While this makes for quite the deadly ability (definitely not what you might expect out of such an unsuspecting pink ball of goo), it does disallow his core ability of adapting to the powers around him.

In conclusion, Kirby’s ability to inhale enemies must link to another location in order for him to fit as much as he does into his stomach. Consequently, this requires the existence of a wormhole in Kirby’s mouth to link to this other location which acts as his stomach. With exotic matter and some theories of how wormholes could be constructed using an arbitrarily low amount of exotic matter, we can conclude that the wormhole could theoretically form. However, this theory cannot hold due to the intense heat that would be produced by the wormhole which is not accounted for in any of his depictions.

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