Wormholes – Gates to the Stars?
How an Einstein-Rosen bridge could destroy our Solar System

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What is a Wormhole?

In 1935, Albert Einstein and Nathaniel Rosen published a study that presented a strange new mathematical object. In form, it looked like two universes with a bridge connecting them. Einstein and Rosen hoped that these bridges could represent particles in Einstein’s general theory of relativity, but later developments in quantum mechanics shattered that idea.

Eventually, John Archibald Wheeler gave them the iconic name ‘wormhole,’ and it stuck. Wheeler’s student, a Logan native named Kip Thorne, went on to publish a landmark paper with Michael Morris examining whether such a bridge could be used for interstellar travel.

Morris and Thorne based their paper on research they had done for their friend Carl Sagan, who used a wormhole as a means of interstellar travel in his 1985 novel Contact. Since then, the wormhole has become a staple of science fiction, most notably featuring in the 2014 film Interstellar.

A wormhole connects two different universes, or two widely separated parts of the same universe. (Figure 2) By traveling through a wormhole, a traveler could quickly arrive at a distant point in space without needing to cross the intervening distance. This could greatly shorten interstellar travel times.

Einstein-Rosen Bridges

Unfortunately, the simple wormholes described by Einstein and Rosen, sometimes called Schwarzschild wormholes, cause serious problems for any future space explorer.

The first, and most glaring, is that they are unstable – they collapse so fast that even an object moving the speed of light could not pass through.

The second problem involves the intense tidal forces. For a person entering a wormhole feet-first, the gravitational force on their feet is stronger than the force on their head. The same is true on Earth, of course, but the difference is so small as to not be noticed.

For a wormhole, however, the field is so strong that the difference in gravitational forces would rip our traveler in pieces.

Solar System: Destroyed

For our experiment, let us follow the lead of Interstellar, and place our wormhole near Saturn.

Luckily for our would-be space travelers, we can solve the problem of tidal gravity by just increasing the mass of our wormhole. How massive would this wormhole have to be for our intrepid explorers to survive?

It turns out it must be 10,000 times the mass of the Sun. Its radius would be 53,000 km, or almost large enough to swallow Saturn whole. And it is certainly enough to rip the rest of the planets out of their orbits and into new ones around the wormhole.

To save the Solar System, we must push the wormhole about 60 times further away than Neptune.

Figure 1 – The black hole Gargantua, from the film Interstellar. An Einstein-Rosen bridge would look very similar to a black hole.

Making Wormholes Work

Faced with problems like these, Morris, Thorne, and others have done research on how to make a wormhole useful for space travel. They were able to find a way to fix the problems caused by the gravitational field, and to make the wormhole stable, but only if we can find matter that has negative energy.

Although later research has shown that we might be able to get away with very small amounts of this exotic matter, we haven’t found a way to get rid of it so far.

However, recent studies of conformal gravity – a special way of extending General Relativity – has shown that we can get rid of exotic matter in other situations where it crops up. With further research, it may work for wormholes too.

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Figure 2 – An embedding diagram of a wormhole

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