

Key points from Lecture 26 of ASTR 350

1. Wormholes are hypothetical; they would connect two regions in spacetime like a tunnel.
2. But initial conceptions were unstable; even a tiny amount of mass or energy, if it passed through a wormhole, would cause the wormhole to collapse at the speed of light.
3. Thus the question is: can we make *traversable* wormholes? This is a question that reputable people started to address when Carl Sagan was in the process of writing *Contact*. He consulted his friend Kip Thorne, and Kip started looking into it.
4. How could you construct a macroscopic wormhole? These flit in and out of existence at the ultramicroscopic level all the time, so maybe you could inflate one somehow. Or, you'd need to twist spacetime around pretty nastily to begin at the macroscopic level.
5. But either way, to make a stable (and thus traversable) wormhole, you need to have the interior made of *exotic matter*, which has a negative energy density(!!!). This can be done, believe it or not (look up "Casimir effect") and it is somewhat like dark energy, so it's not completely ridiculous.
6. If you *can* go from Point A to Point B faster than light normally would (which is what a wormhole would do), then you can travel backward in time.
7. This leads to paradoxes such as the "grandfather paradox", in which you go back in time and kill your grandfather before he can produce your father or mother, which means you can't have existed, which means that you can't go back and kill your grandfather, so you do exist, so you can kill your grandfather...
8. Versions of this exist where you don't have conscious choices to make (e.g., when the time comes you just can't bear to kill baby granddad). The resolution is that the universe can't be self-inconsistent. Unfortunately, this means that we can't have Back to the Future scenarios in which we get a redo to avoid past mistakes...
9. But even with that, time travel might not be possible at all. Quantum fluctuations that go through a wormhole and travel back in time can do it again and again, building up positive energy density that cancels out the negative energy density that was stabilizing the wormhole. The case isn't absolutely closed, though.