What if you flew your warp drive spaceship into a black hole?

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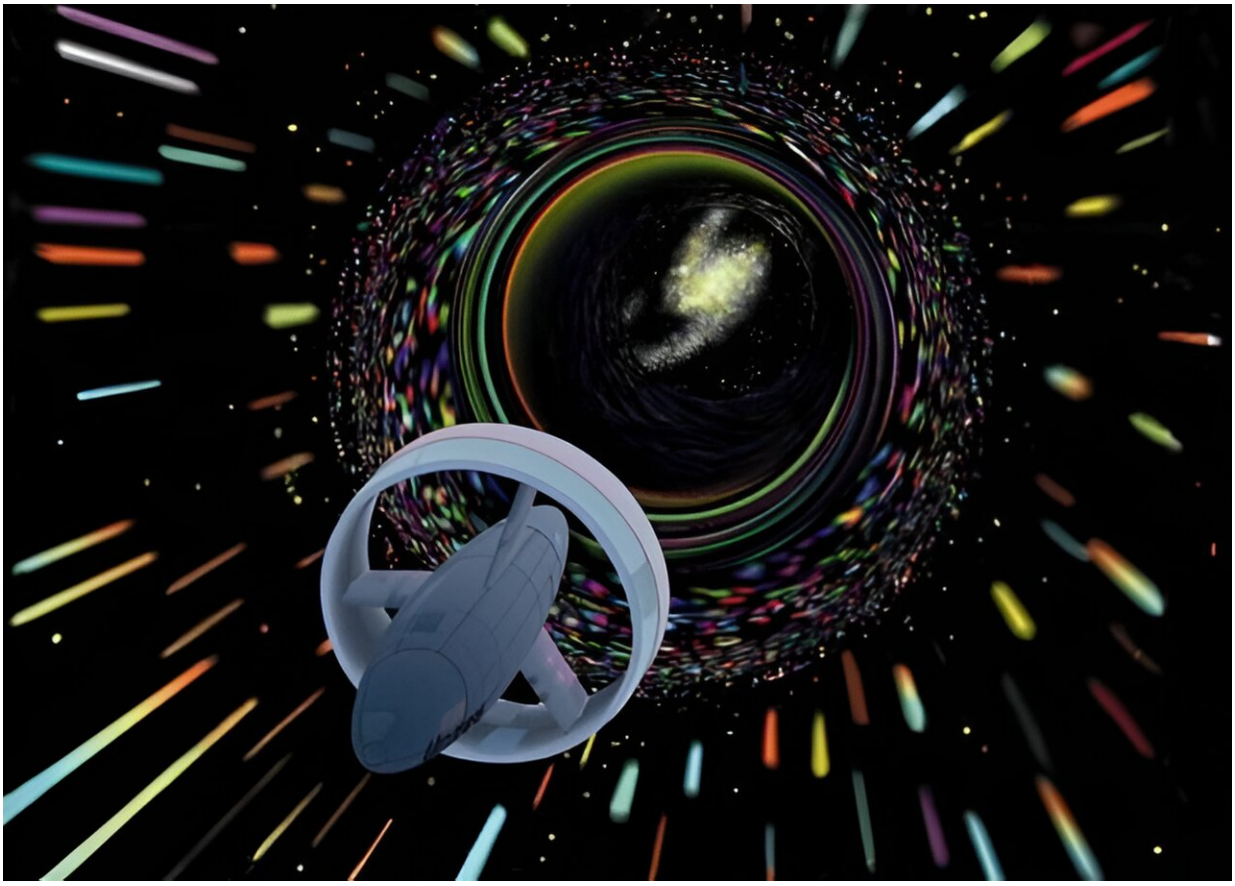

This artist's illustration shows a spacecraft using an Alcubierre Warp Drive to warp space and 'travel' faster than light. Credit: Les Bossinas/NASA/Wikimedia Commons

Warp drives have a long history of not existing, despite their ubiquitous presence in science fiction. Writer John Campbell first introduced the idea in a science fiction novel called Islands of Space.

These days, thanks to Star Trek in particular, the term is very familiar. It's almost a generic reference for superliminal travel through hyperspace. Whether or not warp drive will ever exist is a physics problem that researchers are still trying to solve, but for now, it's theoretical.

Recently, two researchers looked at what would happen if a ship with warp drive tried to get into a black hole. The result is an interesting thought experiment. It might not lead to starship-sized warp drives but might allow scientists to create smaller versions someday. The paper is published in the journal *Physics Letters B*.

Remo Garattini and Kirill Zatrimaylov theorized that such a drive could survive inside a so-called Schwarzschild black hole. That's provided the ship crosses the event horizon at a speed lower than that of light.

Theoretically, the black hole's gravitational field would decrease the amount of negative energy required to keep the drive going. If it did, the ship could pass through and somehow use it to get somewhere else without getting crushed. Furthermore, the mathematics behind this idea points the way toward the possible creation of mini-warp drives in lab settings.

What's a warp drive?

Could scientists build a micro- or mini-warp drive in the lab? Good questions. To understand the team's work, let's look at the major players in this research: warp drives and black holes.

The idea is inspired by the fact that nothing can go faster than light speed. Given the distances in space, traveling to the nearest star would take years (if we could go at light speed). Going across a galaxy or to more distant galaxies would take years and many lifetimes. So, if you want to be a space-faring species, you must travel faster than light (FTL).

How would you do that? This is where warp drives come in. Theoretically, they allow you to put your spaceship inside a bubble that could slip through space at FTL speeds. That's how the starships in Star Trek (and other SF stories) get across huge distances so quickly. The Star Trek ships use an energy source in a "warp core" to power warp field generators. They create the warp bubble in subspace. The ship uses that to go wherever the crew needs to be.

Do physicists like warp drive?

Such a warp drive is a tantalizing idea with many caveats. For example, generating a warp field requires an insane amount of energy. Some physicists suggest that it would take more energy than we're capable of generating. Creating that energy would require huge amounts of exotic matter—something like "unobtanium." So, that's a problem right there.

Others say that creating such a drive goes against our current understanding of spacetime physics. However, that hasn't stopped anybody from speculating on ways to make it happen. For example, Mexican physicist Miguel Alcubierre had an idea for such a drive in 1994. He suggested that it could create a bubble that would shift space around an object.

He has continued his research about a ship that could get somewhere faster than light. However, he and others still point out various problems with both creating and sustaining a warp drive. That includes the idea

that such a drive effectively isolates itself from the rest of the universe. Among other things, it means the ship can't control the drive that's making it go. So, there are still a few bugs to work out.

About black holes

We are most familiar with black holes in terms of stellar mass and supermassive ones. These also sport accretion disks that convey material into the black hole. For example, the central supermassive black hole named Sagittarius A* in our own Milky Way galaxy periodically gobbles down material. Then, it emits a belch of radiation. Other, more active galaxies send out jets of material emitted as the central supermassive black hole feeds continuously.

A black hole is a concentration of mass with gravity so strong that nothing, even light, can escape. In their study about black holes and warp drives, the authors used Schwarzschild black holes. These so-called simple "static" black holes curve spacetime, have no electric charge and are non-rotating. Essentially, they are good approximations for mathematical explorations of the characteristics of slowly rotating objects in space.

When a ship with warp drive crosses into a black hole

The Schwarzchild black hole is the "perfect" black hole to use in this theoretical exploration of a warp drive crossing the event horizon. To figure out the scenario, Garattini and Zatrimalov decided to mathematically combine the equations describing the black hole and the ones describing the warp drive.

Among other things, they found that it's possible to "embed" the warp drive in the outer region of the black hole. The warp bubble itself is

much smaller than the black hole and needs to be moving toward it. The black hole's gravity affects the energy conditions needed to create and sustain the warp drive.

That means you can theoretically decrease the amount of negative energy required to sustain the warp bubble. In addition, the researchers suggest that if the warp bubble is moving at less than the speed of light, it effectively erases the black hole horizon.

The research team also described the idea that such an occurrence could evoke the conversion of virtual particles into real ones in an electric field. If so, it could lead to the creation of mini warp drives in the lab.

Changing the black hole a bit

Interestingly, the team also suggests that, if the warp bubble is moving slowly and is much smaller than the black hole horizon, it could increase the entropy of the black hole. However, as they state in their closing arguments, "there are potential problematic issues in other physical situations: namely, when the warp drive is completely absorbed by the black hole, it may decrease its mass, and, therefore, its entropy.

Likewise, when there is a larger warp bubble passing through a black hole, it would produce a "screening" effect and de facto eliminate the horizon, making it impossible to define the black hole entropy in the Hawking sense. If warp drives are possible in nature, these issues indicate that we still do not understand them from the thermodynamic point of view."

Warp drive technology remains to be seen

So, while this research may prove valuable theoretically, and could lead

to lab production of mini black holes, many questions remain. Perhaps in the future, when we understand the quantum mechanics behind both of these objects, we might find warp technology a slam-dunk.

If so, then, as ships travel through black holes, we could face a weird time. For example, signals from inside a black hole could get carried out by a warp bubble merging from the singularity. That would allow us to send images or recordings of what it's like inside the event horizon—something nobody knows about today.

There's also a chance that those fearsome black holes could make a warp drive less difficult to achieve, since they won't need so much exotic "negative energy" source material.

More information: Remo Garattini et al, Black holes, warp drives, and energy conditions, *Physics Letters B* (2024). DOI: 10.1016/j.physletb.2024.138910

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