

New study simulates gravitational waves from failing warp drive

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AI impression of a warp bubble collapse. Credit: Katy Clough with AI tool pixlr.com

Imagine a spaceship driven not by engines, but by compressing the spacetime in front of it. That's the realm of science fiction, right? Well, not entirely. Physicists have been exploring the theoretical possibility of

"warp drives" for decades, and a new study [published](#) in the *Open Journal of Astrophysics* takes things a step further—simulating the gravitational waves such a drive might emit if it broke down.

Warp drives are staples of science fiction, and in principle could propel spaceships faster than the speed of light. Unfortunately, there are many problems with constructing them in practice, such as the requirement for an exotic type of matter with negative energy.

Other issues with the warp drive metric include the potential to use it to create closed time-like curves that violate causality and, from a more practical perspective, the difficulties for those in the ship in actually controlling and deactivating the bubble.

This new research is the result of a collaboration between specialists in gravitational physics at Queen Mary University of London, the University of Potsdam, the Max Planck Institute (MPI) for Gravitational Physics in Potsdam and Cardiff University. While it doesn't claim to have cracked the warp drive code, it explores the theoretical consequences of a warp drive "containment failure" using numerical simulations.

Dr. Katy Clough of Queen Mary University of London, the first author of the study, explains, "Even though warp drives are purely theoretical, they have a well-defined description in Einstein's theory of General Relativity, and so [numerical simulations](#) allow us to explore the impact they might have on spacetime in the form of [gravitational waves](#)."

Co-author Dr. Sebastian Khan, from Cardiff University's School of Physics and Astronomy, adds, "Miguel Alcubierre created the first warp drive solution during his Ph.D. at Cardiff University in 1994, and subsequently worked at the MPI in Potsdam. So it's only natural that we carry on the tradition of warp drive research in the era of gravitational

wave astronomy ."

The results are fascinating. The collapsing warp drive generates a distinct burst of gravitational waves, a ripple in spacetime that could be detectable by [gravitational wave detectors](#) that normally target black hole and neutron star mergers. Unlike the chirps from merging astrophysical objects, this signal would be a short, high-frequency burst, and so current detectors wouldn't pick it up.

However, future higher-frequency instruments might, and although no such instruments have yet been funded, the technology to build them exists. This raises the possibility of using these signals to search for evidence of warp drive technology, even if we can't build it ourselves.

Dr. Khan cautions, "In our study, the initial shape of the spacetime is the warp bubble described by Alcubierre. While we were able to demonstrate that an observable signal could in principle be found by future detectors, given the speculative nature of the work, this isn't sufficient to drive instrument development."

The study also delves into the energy dynamics of the collapsing warp drive. The process emits a wave of negative energy matter, followed by alternating positive and negative waves. This complex dance results in a net increase in the overall energy of the system, and in principle could provide another signature of the collapse if the outgoing waves interacted with normal matter.

This research pushes the boundaries of our understanding of exotic spacetimes and gravitational waves. Prof Dietrich comments, "For me, the most important aspect of the study is the novelty of accurately modeling the dynamics of negative energy spacetimes, and the possibility of extending the techniques to physical situations that can help us better understand the evolution and origin of our universe, or the

avoidance of singularities at the center of [black holes](#)."

Dr. Clough adds, "It's a reminder that theoretical ideas can push us to explore the universe in new ways. Even though we are skeptical about the likelihood of seeing anything, I do think it is sufficiently interesting to be worth looking at."

The researchers plan to investigate how the signal changes with different [warp](#) drive models and explore the collapse of bubbles traveling at speeds exceeding the speed of light itself. Warp speed may be a long way off, but the quest to understand the universe's secrets continues, one simulated crash at a time.

More information: Katy Clough et al, What no one has seen before: gravitational waveforms from warp drive collapse, *The Open Journal of Astrophysics* (2024). DOI: [10.33232/001c.121868](https://doi.org/10.33232/001c.121868). On *arXiv*: DOI: [10.48550/arxiv.2406.02466](https://doi.org/10.48550/arxiv.2406.02466)

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