'Glitches' of rapidly spinning neutron star pulsars can be a source of gravitational waves

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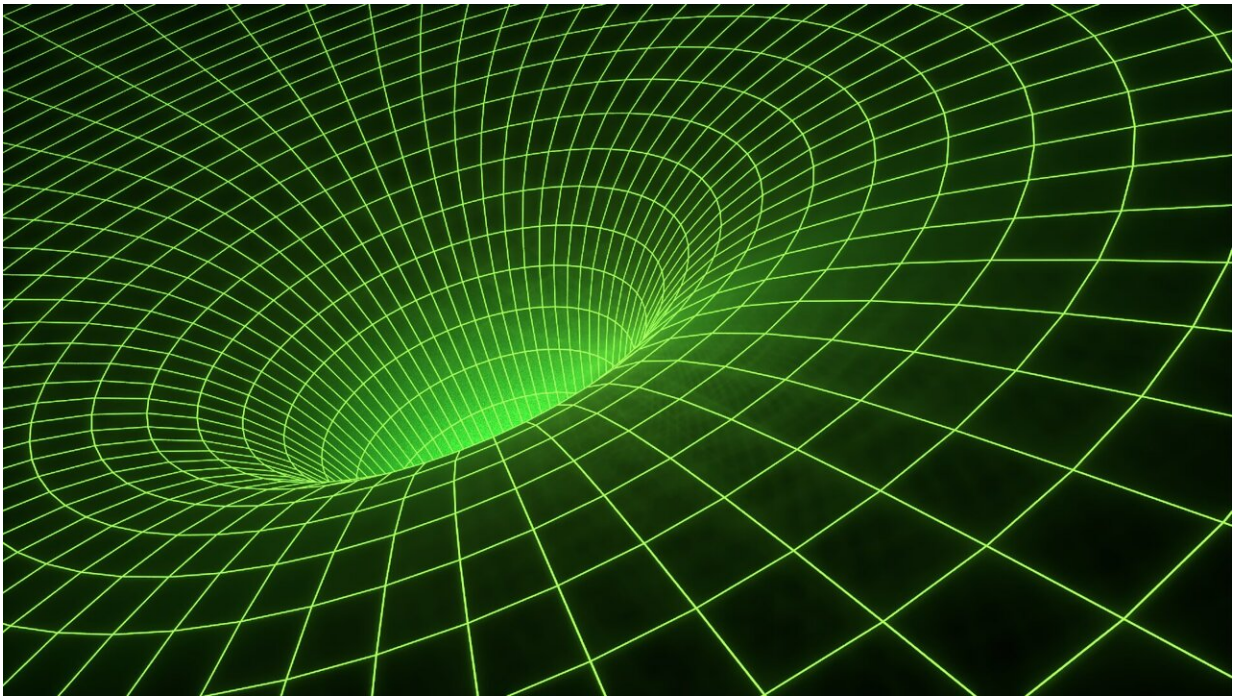

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Observing gravitational waves from neutron stars as they glitch could help us understand these exotic stellar remnants.

Neutron stars are considered to be the most extreme and exotic celestial objects in the known universe. Created when a massive star runs out of fuel for nuclear fusion and its stellar core collapses, neutron stars pack

one or two times the mass of the sun into a width of around 12 miles (20 kilometers).

As a result, the matter that comprises a neutron star is so dense that a single teaspoon of it brought to Earth would weigh 10 million US tons, according to the US Department of Energy. Yet, this collapse leads to another extreme characteristic. Just as an ice skater draws in their arms to increase their spin, the rapid shrinking of a neutron star's diameter "speeds up" its rotation. That results in some neutron stars spinning as fast as 700 times a second.

When they blast radiation from their poles, these neutron stars sweep radiation across the cosmos like celestial lighthouses and are known as pulsars. These are subject to "glitches" that occur when they suddenly and somewhat mysteriously speed up.

A paper published in the journal *Astroparticle Physics* by Brynmor Haskell, an associate professor at the Nicolaus Copernicus Astronomical Center (CAMK), Warsaw, Poland, and Ian Jones of the University of Southampton, UK, suggests that these glitches should be accompanied by the emission of ripples in the very fabric of spacetime: gravitational waves.

The authors point out that these "spin-up" occurrences for neutron stars are theorized to be connected to the presence of vortices in the superfluid components of the neutron star interior. Depending on the physical mechanisms at play during these periods, different phases of the glitch may emit gravitational waves of different frequencies.

Haskell and Jones suggest that rapid short bursts of gravitational waves could accompany the glitch itself, while the post-glitch response, or "relaxation" of the pulsar back to its original rate of rotation, could be accompanied by the emission of longer-lasting gravitational waves. The

team even suggests that the long-term changes which occur in the interior and surface of glitching pulsars could lead to persistent gravitational wave signals.

Ultimately, listening to the gravitational wave music played by pulsars may help determine the dynamics at play within neutron stars.

More information: B. Haskell et al, Glitching pulsars as gravitational wave sources, *Astroparticle Physics* (2023). DOI: 10.1016/j.astropartphys.2023.102921

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