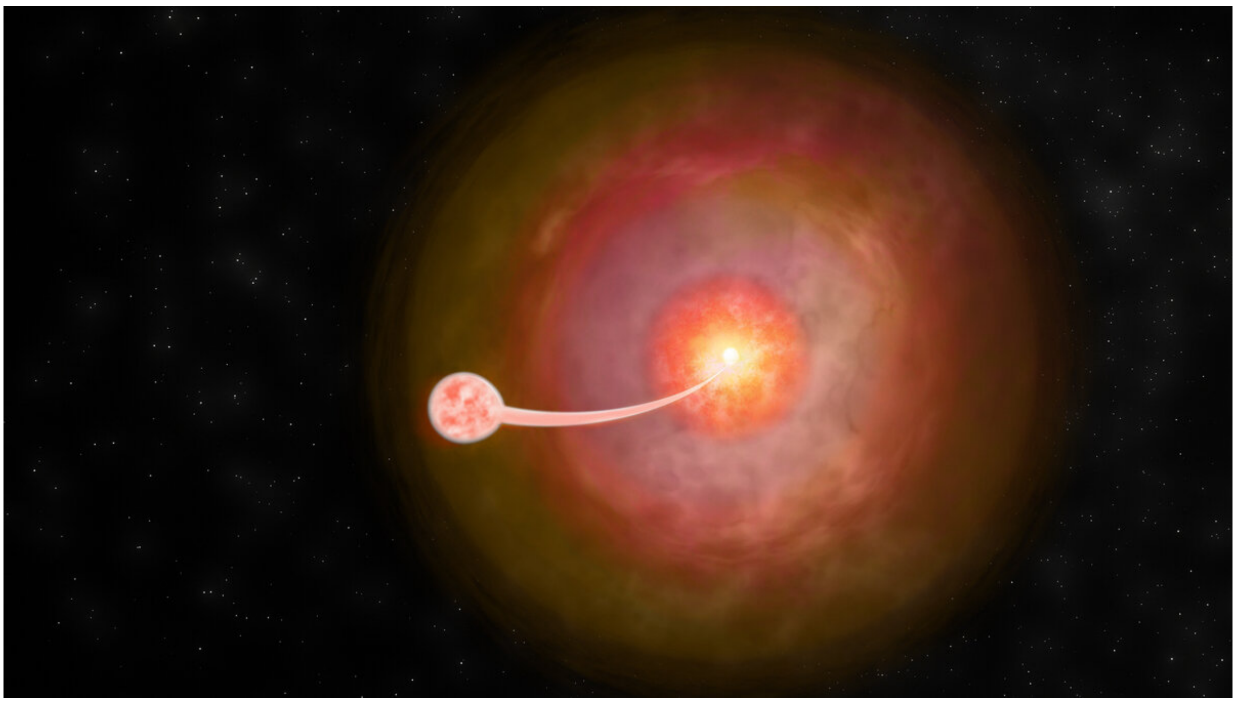
Not your average space explosion: Very long baseline array finds classical novae are anything but simple

June 6 2023, by Amy C. Oliver



This artist's conception depicts V1674 Herculis, a classical nova hosted in a binary star system that is made up of a white dwarf and dwarf companion star. Scientists studying this nova have detected non-thermal emission, a departure from the historical belief that these systems produce only thermal emissions. Credit: B. Saxton (NRAO/AUI/NSF)

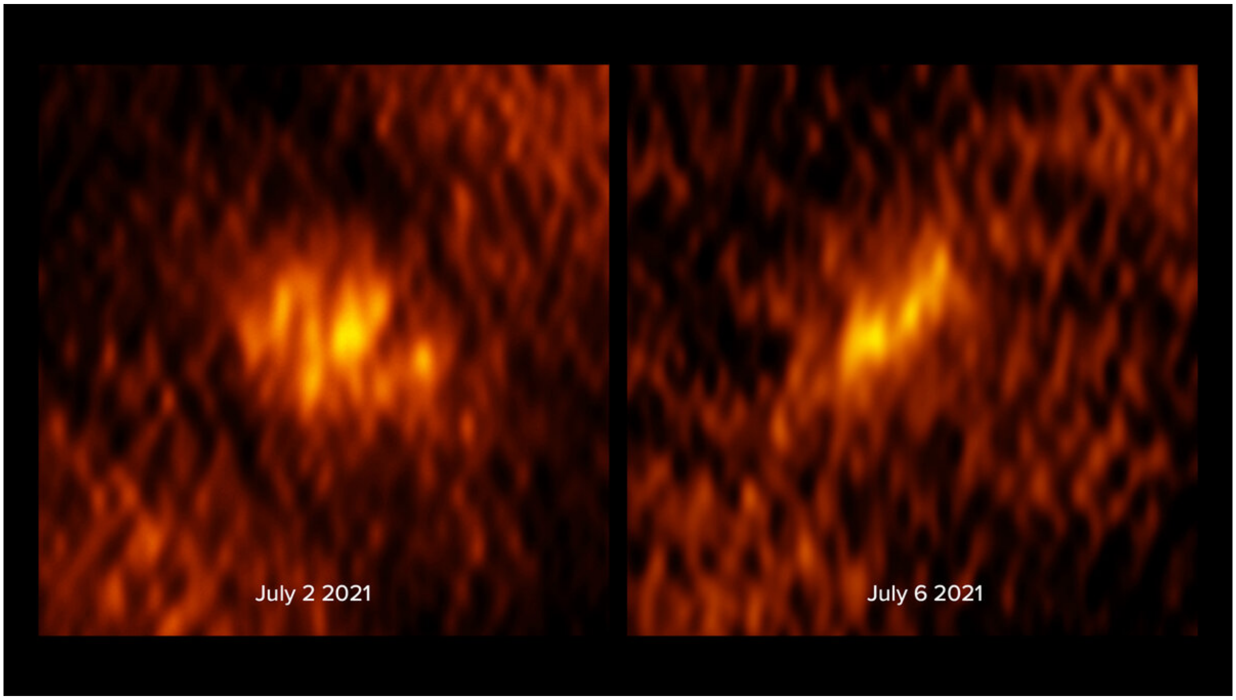
While studying classical novae using the National Radio Astronomy

Observatory's Very Long Baseline Array (VLBA), a graduate researcher uncovered evidence showing that the objects may have been erroneously typecast as simple. The new observations, which detected non-thermal emission from a classical nova with a dwarf companion, were presented at a press conference during the 242nd proceedings of the American Astronomical Society in Albuquerque, New Mexico.

V1674 Herculis is a classical nova hosted by a white dwarf and dwarf companion and is currently the fastest classical nova on record. While studying V1674Her with the VLBA, Montana Williams, a graduate student at New Mexico Tech who is leading the investigation into the VLBA properties of this nova, confirmed the unexpected: non-thermal emission coming from it. This data is important because it tells Williams and collaborators a lot about what's happening in the system. What the team has found is anything but the simple heat-induced explosions scientists previously expected from classical novae.

"Classical novae have historically been considered simple explosions, emitting mostly thermal energy," said Williams. "However, based on recent observations with the Fermi Large Area Telescope, this simple model is not entirely correct. Instead, it seems they're a bit more complicated. Using the VLBA, we were able to get a very detailed picture of one of the main complications, the non-thermal emission."

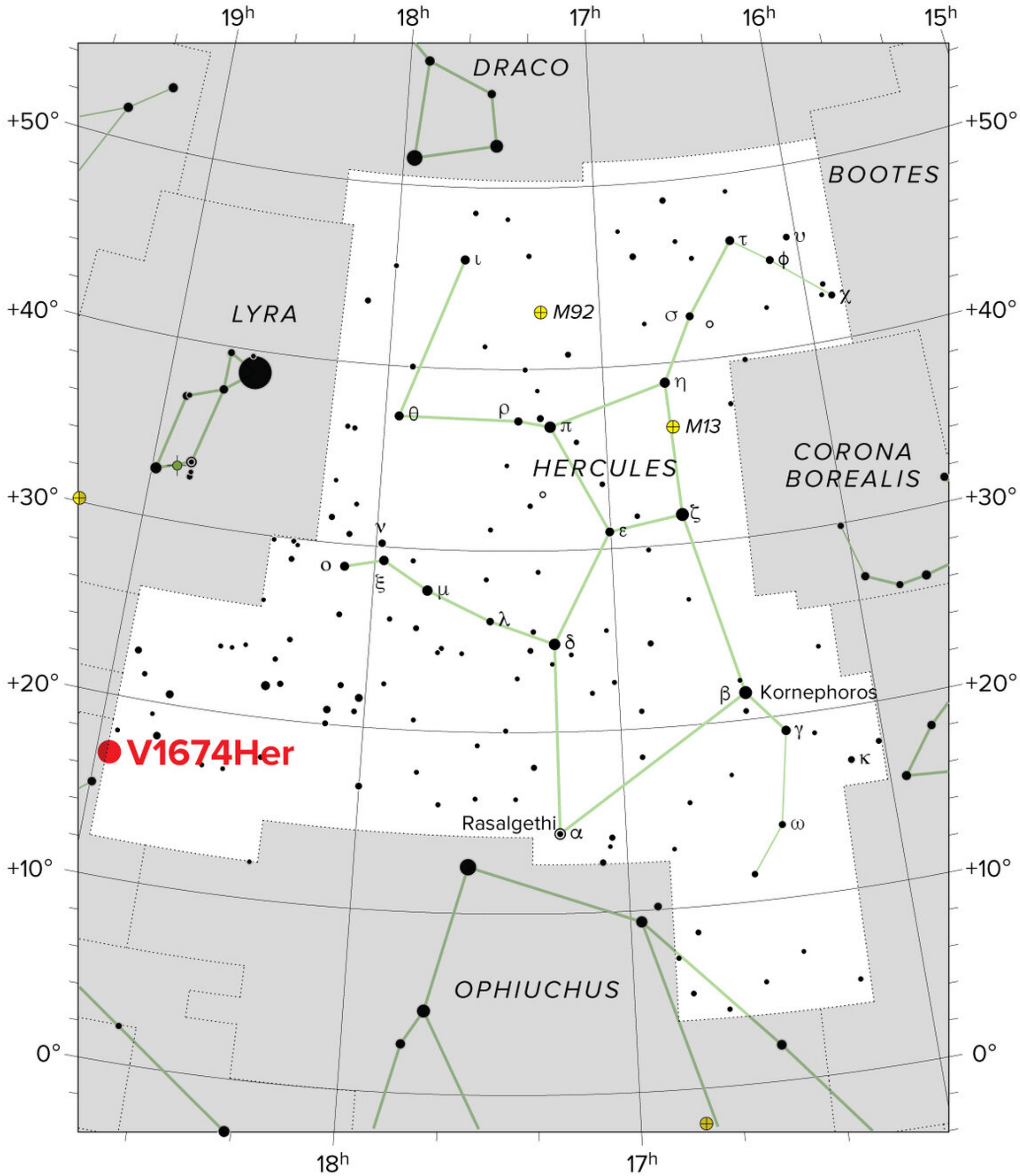
Very long baseline interferometry (VLBI) detections of classical novae with dwarf companions like V1674Her are rare. They're so rare, in fact, that this same type of detection, with resolved radio synchrotron components, has been reported just one other time to date. That's partly because of the assumed nature of classical novae.



Scientists studying the classical nova V1674Her have confirmed the presence of non-thermal emissions. The nova, which was discovered in 2021, is the fastest classical nova on record. This side-by-side shows the difference in brightness over just four days. Credit: M. Williams/New Mexico Tech, B. Saxton (NRAO/AUI/NSF)

"VLBI detections of novae are only recently becoming possible because of improvements to VLBI techniques, most notably the sensitivity of the instruments and the increasing bandwidth or the amount of frequencies we can record at a given time," said Williams. "Additionally, because of the previous theory of classical novae they weren't thought to be ideal targets for VLBI studies. We now know this isn't true because of multi-wavelength observations which indicate a more complex scenario."

That rarity makes the team's new observations an important step in understanding the hidden lives of classical novae and what ultimately leads to their explosive behavior.



V1674Her is a classical nova located in the constellation Hercules. Credit: IAU/Sky & Telescope

"By studying images from the VLBA and comparing them to other observations from the Very Large Array (VLA), Fermi-LAT, Nu-Star, and NASA-Swift, we can determine what might be the cause of the emission and also make adjustments to the previous simple model," said Williams. "Right now, we're trying to determine if the non-thermal energy is coming from clumps of gas running into other clumped gas which produces shocks, or something else."

Because Fermi-LAT and Nu-Star observations had already indicated that there might be non-thermal emission coming from V1674Her, that made the classical nova an ideal candidate for study because the team are on a mission to either confirm or deny those types of findings. It was also more interesting, or cute, as Williams puts it, because of its hyper-fast evolution, and because, unlike supernovae, the host system isn't destroyed during that evolution, but rather, remains almost completely intact and unchanged after the explosion.

"Many astronomical sources don't change much over the course of a year or even 100 years. But this nova got 10,000 times brighter in a single day, then faded back to its normal state in just about 100 days," Williams said. "Because the host systems of classical novae remain intact they can be recurrent, which means we might see this one erupt, or cutely explode, again and again, giving us more opportunities to understand why and how it does."

Provided by National Radio Astronomy Observatory