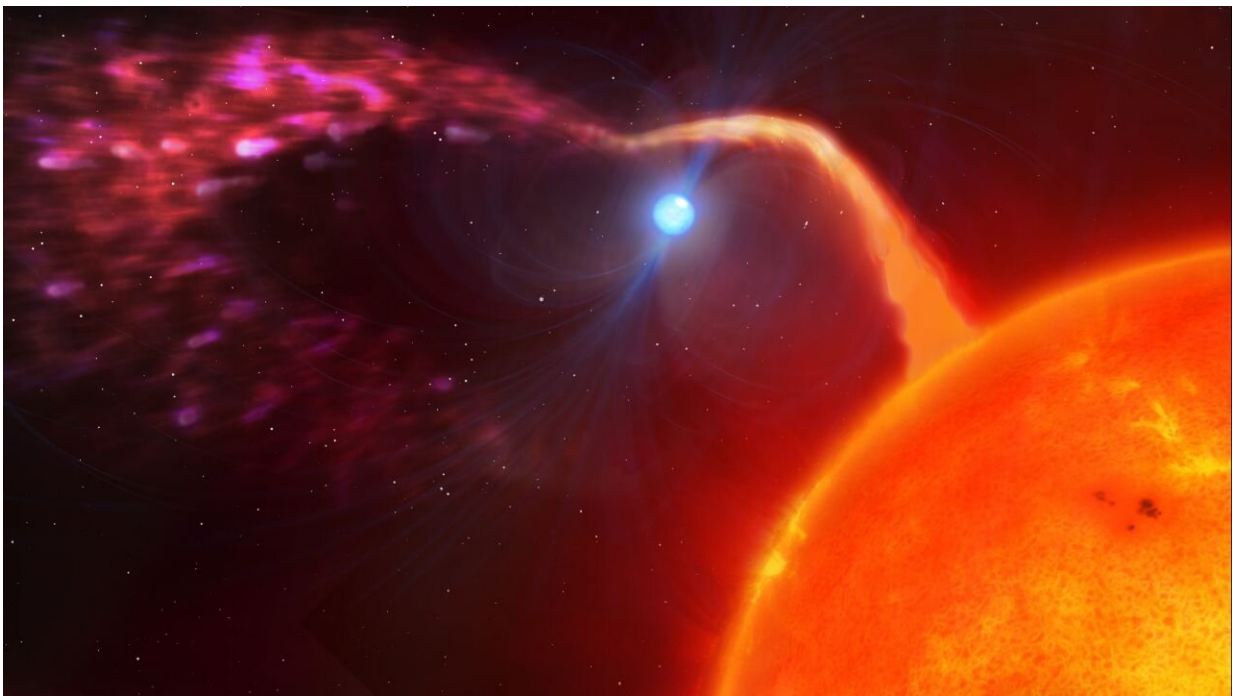


# High-speed propeller star is fastest spinning confirmed white dwarf

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Artist's impression credit: University of Warwick/Mark Garlick

A white dwarf star that completes a full rotation once every 25 seconds is the fastest spinning confirmed white dwarf, according to a team of astronomers from the Universities of Sheffield and Warwick.

They have established the spin period of the star for the first time, confirming it as an extremely rare example of a magnetic propeller

system: the white dwarf is pulling gaseous plasma from a nearby companion star and flinging it into space at around 3000 kilometers per second.

Reported today in the journal *Monthly Notices of the Royal Astronomical Society*, it is only the second magnetic propeller white dwarf to have been identified in over 70 years thanks to a combination of powerful and sensitive instruments that allowed scientists to catch a glimpse of the speeding star.

The study was performed by the Universities of Sheffield and Warwick, and funded by the Science and Technology Facilities Council (STFC), part of UK Research and Innovation, and the Leverhulme Trust.

A white dwarf is a star that has burnt up all of its fuel and shed its outer layers, now undergoing a process of shrinking and cooling over millions of years. The star that the Sheffield and Warwick team observed, named LAMOST J024048.51+195226.9—or J0240+1952 for short, is the size of the Earth but is thought to be at least 200,000 times more massive. It is part of a binary star system and its immense gravity is pulling material from its larger companion star in the form of plasma.

In the past, this plasma was falling onto the white dwarf's equator at high speed, providing the energy that has given it this dizzyingly fast spin. Put into context, one rotation of the planet Earth takes 24 hours, while the equivalent on J0240+1952 is a mere 25 seconds. That's almost 20 percent faster than the confirmed white dwarf with the most comparable spin rate, which completes a rotation in just over 29 seconds.

However, at some point in its evolutionary history J0240+1952 developed a strong magnetic field. The magnetic field acts as a protective barrier, causing most of the falling plasma to be propelled away from the white dwarf. The remainder will flow towards the star's

magnetic poles. It gathers in bright spots on the surface of the star and as these rotate in and out of view they cause pulsations in the light that the astronomers observe from Earth, which they then used to measure the rotation of the entire star.

Lead author Dr. Ingrid Pelisoli of the University of Warwick Department of Physics, said that "J0240+1952 will have completed several rotations in the short amount of time that people take to read about it, it is really incredible. The rotation is so fast that the white dwarf must have an above average mass just to stay together and not be torn apart."

"It is pulling material from its companion star due to its gravitational effect, but as that gets closer to the white dwarf the magnetic field starts to dominate. This type of gas is highly conducting and picks up a lot of speed from this process, which propels it away from the star and out into space."

J0240+1952 is one of only two stars with this magnetic propeller system discovered in the past 70 years. Although material being flung out of the star was first observed in 2020, astronomers had not been able to confirm the rapid spin that is a main ingredient of a magnetic propeller, as the pulses are too fast and dim for other telescopes to observe.

To visualize the star at that speed for the first time, the team used the highly sensitive HiPERCAM instrument, which was designed and built by a consortium led by the University of Sheffield and funded by a European Research Council Advanced Grant. HiPERCAM is mounted on the world's largest optical telescope, the 10.4 meter diameter Gran Telescopio Canarias (GTC) on La Palma, to capture as much light as possible.

Co-author and Principal Investigator of HiPERCAM, Professor Vik

Dhillon of the University of Sheffield, said that "this discovery was only made possible by combining the unique high-speed and multi-wavelength capabilities of HiPERCAM with the light-gathering power of the GTC."

Co-author Professor Tom Marsh from the University of Warwick's Department of Physics added that "it's only the second time that we have found one of these magnetic propeller systems, so we now know it's not a unique occurrence. It establishes that the magnetic propeller mechanism is a generic property that operates in these binaries, if the circumstances are right."

"The second discovery is almost as important as the first as you develop a model for the first and with the second you can test it to see if that model works. This latest discovery has shown that the model works really well, it predicted that the star had to be spinning fast, and indeed it does."

Provided by University of Sheffield

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