

A crystal ball into our solar system's future

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Artist's rendition of a newly-discovered Jupiter-like exoplanet orbiting a white dwarf, or dead star. This system is evidence that planets can survive their host star's explosive red giant phase and is the very first confirmed planetary system that serves as an analog to the fate of the Sun and Jupiter in our own solar system. Credit: W. M. Keck Observatory/Adam Makarenko

Astronomers have discovered the very first confirmed planetary system

that resembles the expected fate of our solar system, when the Sun reaches the end of its life in about five billion years.

The researchers detected the system using W. M. Keck Observatory on Maunakea in Hawai'i; it consists of a Jupiter-like planet with a Jupiter-like orbit revolving around a [white dwarf star](#) located near the center of our Milky Way galaxy.

"This evidence confirms that planets orbiting at a large enough distance can continue to exist after their star's death," says Joshua Blackman, an astronomy postdoctoral researcher at the University of Tasmania in Australia and lead author of the study. "Given that this system is an analog to our own solar system, it suggests that Jupiter and Saturn might survive the Sun's red giant phase, when it runs out of [nuclear fuel](#) and self-destructs."

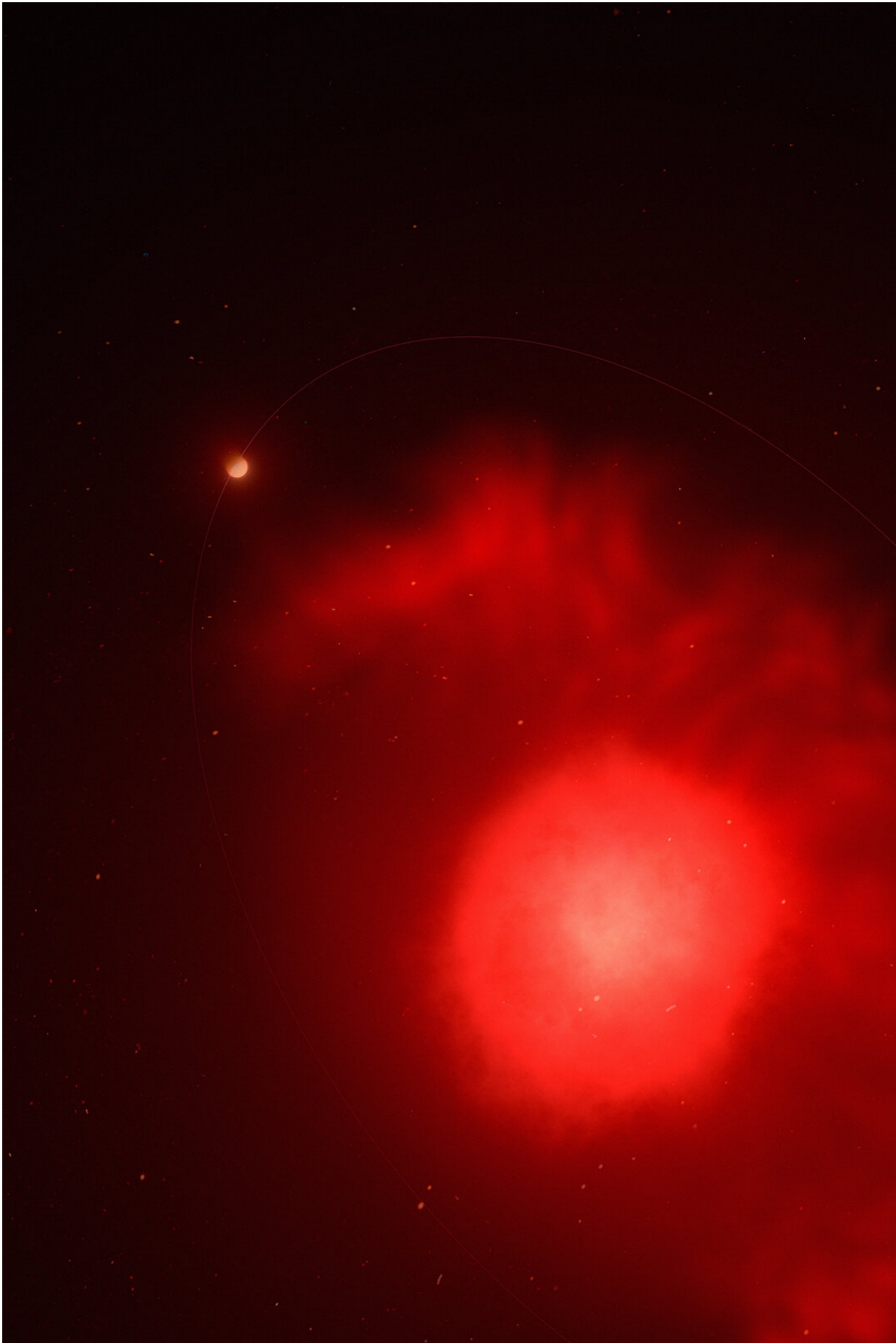
The study is published in today's issue of the journal *Nature*.

"Earth's future may not be so rosy because it is much closer to the Sun," says co-author David Bennett, a senior research scientist at the University of Maryland and NASA's Goddard Space Flight Center. "If humankind wanted to move to a moon of Jupiter or Saturn before the Sun fried the Earth during its red supergiant phase, we'd still remain in orbit around the Sun, although we would not be able to rely on heat from the Sun as a white dwarf for very long."

A white dwarf is what [main sequence stars](#) like our Sun become when they die. In the last stages of the stellar life cycle, a star burns off all of the hydrogen in its core and balloons into a red giant star. It then collapses into itself, shrinking into a white dwarf, where all that's left is a hot, dense core, typically Earth-sized and half as massive as the Sun. Because these compact stellar corpses are small and no longer have the nuclear fuel to radiate brightly, [white dwarfs](#) are very faint and difficult

to detect.

High-resolution near-infrared images obtained with Keck Observatory's laser guide star adaptive optics system paired with its Near-Infrared Camera (NIRC2) reveal the newly-discovered white dwarf is about 60 percent of the Sun's mass and its exoplanet survivor is a giant gas world that's about 40 percent more massive than Jupiter.

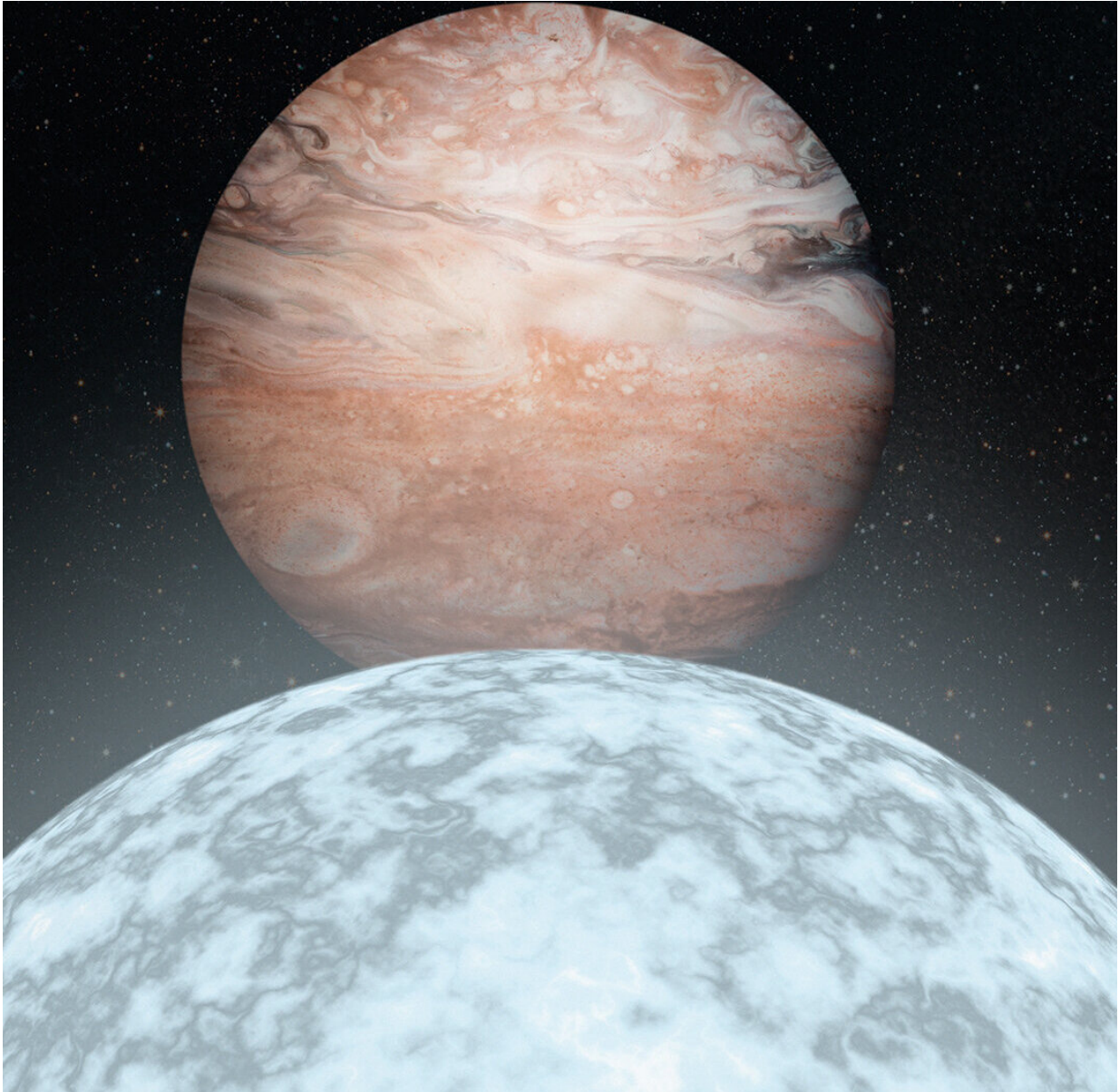


Artist rendering of a dying sequence star with an orbiting planet. The star is in the red giant phase when it burns the last of its nuclear fuel before collapsing in on itself and forming a smaller, fainter white dwarf. Credit: W. M. Keck Observatory/Adam Makarenko

The team discovered the planet using a technique called gravitational microlensing, which occurs when a star close to Earth momentarily aligns with a more distant star. This creates a phenomenon where gravity from the foreground star acts like a lens and magnifies the light from the background star. If there is a planet orbiting the closer star, it temporarily warps the magnified light as the planet whizzes by.

Strangely, when the team tried to look for the planet's [host star](#), they unexpectedly discovered the starlight wasn't bright enough to be an ordinary, main sequence star. The data also ruled out the possibility of a brown dwarf star as the host.

"We have also been able to rule out the possibility of a neutron star or a black hole host. This means that the planet is orbiting a dead star, a white dwarf," says co author Jean-Philippe Beaulieu, Professor, Warren chair of Astrophysics at the University of Tasmania and Directeur de Recherche CNRS at the Institut d'Astrophysique de Paris. "It offers a glimpse into what our solar system will look like after the disappearance of the Earth, whipped out in the cataclysmic demise of our Sun."



Artist rendering of Jupiter and its white dwarf host. If humans survive to see the Sun die, they could theoretically move to a Jovian moon and remain safely in orbit. However, they could not rely on the diminished heat from the stellar corpse of our Sun once it collapses into a white dwarf. Credit: W. M. Keck Observatory/Adam Makarenko

The research team plans to include their findings in a statistical study to

find out how many other white dwarfs have intact, planetary survivors.

NASA's upcoming mission, the Nancy Grace Roman Telescope (formerly known as WFIRST), which aims to directly image giant planets, will help further their investigation. Roman will be capable of doing a much more complete survey of planets orbiting white dwarfs located all the way into the Galactic bulge at the center of the Milky Way. This will allow astronomers to determine whether it is common for Jupiter-like planets to escape their star's final days, or if a significant fraction of them are destroyed by the time their host stars become red giants.

"This is an extremely exciting result," says John O'Meara, chief scientist at Keck Observatory. "It's wonderful to see today an example of the kind of science Keck will be doing en masse when Roman begins its mission."

More information: Joshua Blackman, A Jovian Analog Orbiting a White Dwarf Star, *Nature* (2021). [DOI: 10.1038/s41586-021-03869-6](https://doi.org/10.1038/s41586-021-03869-6)

Provided by W. M. Keck Observatory

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