Unique eclipsing binary star system discovered

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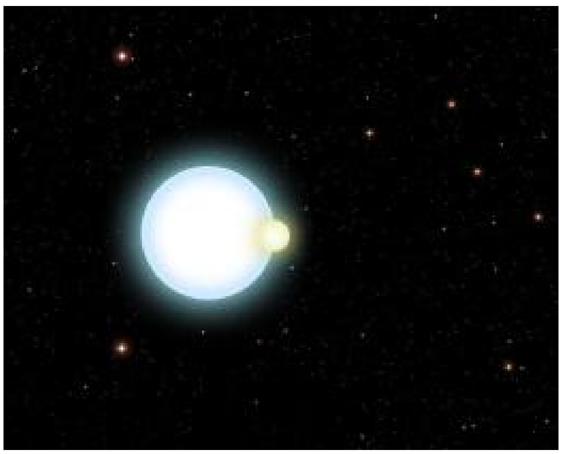

In this artist conception of the unique binary star NLTT 11748, the larger but less massive helium white dwarf star is partially eclipsed by the smaller but more massive normal white dwarf, which is about the size of the earth. Image credit: Steve Howell/Pete Marenfeld/NOAO

(PhysOrg.com) -- Astrophysicists at UC Santa Barbara are the first scientists to identify two white dwarf stars in an eclipsing binary system, allowing for the first direct radius measurement of a rare white dwarf composed of pure helium. The results will be published in the *Astrophysical Journal Letters*. These observations are the first to confirm a theory about a certain type of white dwarf star.

The story began with observations by Justin Steinfadt, a UCSB physics graduate student who has been monitoring white dwarf stars as part of his Ph.D. thesis with Lars Bildsten, a professor and permanent member of UCSB's Kavli Institute for Theoretical Physics, and Steve Howell, an astronomer at the National Optical Astronomy Observatory (NOAO) in Tucson, Ariz.

Brief eclipses were discovered during observations of the star NLTT 11748 with the Faulkes Telescope North of the Las Cumbres Observatory Global Telescope (LCOGT), a UCSB-affiliated institution. NLTT 11748 is one of the few very low-mass, helium-core white dwarfs that are under careful study for their brightness variations. Rapid snapshots of the star -- about one exposure every minute -- found a few consecutive images where the star was slightly fainter. Steinfadt quickly realized the importance of this unexpected discovery. "We've been looking at a lot of stars, but I still think we got lucky!" he said.

Avi Shporer, a postdoctoral fellow at UCSB and LCOGT, assisted with the observations and quickly brought his expertise to the new discovery. "We knew something was unusual, especially as we confirmed these dips the next night," Shporer said. The scientists observed three-minute eclipses of the binary stars twice during the 5.6-hour orbit.

The excitement of the discovery and the need to confirm it rapidly led to the use of the 10-meter Keck Telescope, located on Mauna Kea in Hawaii, just five weeks after the first observation. The team also brought in David Kaplan, a Hubble Fellow and KITP postdoctoral fellow. Bildsten and Kaplan arranged for use of the Keck by swapping time they had reserved for another project with Geoff Marcy at UC Berkeley.

During that night, the scientists were able to measure the changing Doppler shift of the star NLTT 11748 as it orbited its faint, but more massive, white dwarf companion. "It was amazing to witness the velocity of this star change in just a few minutes," said Kaplan, who was present at the Keck telescope during the observations.

These observations led to the confirmation of an important theory about white dwarf stars. Stars end their lives in many ways. "The formation of such a binary system containing an extremely low mass helium white dwarf has to be the result of interactions and mass loss between the two original stars," said Howell. White dwarf stars are the very dense remnants of stars like the sun, with dimensions comparable to the earth. A star becomes a white dwarf when it has exhausted its nuclear fuel and all that remains is the dense inner core, typically made of carbon and oxygen.

One of the stars in the newly discovered binary is a relatively rare helium-core white dwarf with a mass only 10 to 20 percent of that of the sun. The existence of these special stars has been known for more than 20 years. Theoretical work predicted that these stars burn hotter and are larger than ordinary white dwarfs. Until now, their size had never been measured. The observations of the star NLTT 11748 by this research group have yielded the first direct radius measurement of an unusual white dwarf that confirms this theory.

The other star in the binary is also a white dwarf, albeit a more ordinary one, composed of mostly carbon and oxygen with about 70 percent of the mass of the sun. This star is more massive and also much smaller than the other white dwarf. The light it gives off is 30 times fainter than that of its partner star in the binary.

Bildsten credits the scientific collaborations at UCSB for the success of this work, noting that the original team was expanded to include KITP, the Physics Department, and LCOGT to quickly respond to the new discovery.

"A particularly intriguing possibility to ponder is what will happen in 6 to 10 billion years," said Bildsten. "This binary is emitting gravitational waves at a rate that will force the two white dwarfs to make contact.

What happens then is anybody's guess."

Provided by University of California - Santa Barbara