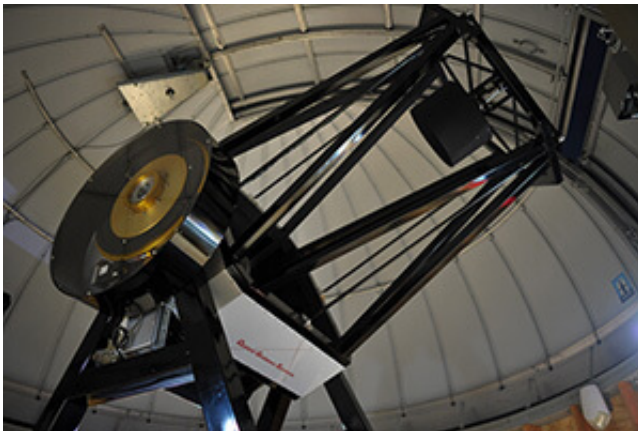


Astrophysicists discover dimming of binary star

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Sarah L. Krizmanich Telescope. Credit: University of Notre Dame

A team of University of Notre Dame astrophysicists led by Peter Garnavich, professor of physics, has observed the unexplained fading of an interacting binary star, one of the first discoveries using the University's Sarah L. Krizmanich Telescope.

The [binary star](#), FO Aquarii, located in the Milky Way galaxy and Aquarius constellation about 500 light-years from Earth, consists of a white dwarf and a companion star donating gas to the compact dwarf, a type of binary system known as an intermediate polar. The system is bright enough to be observed with small telescopes. Garnavich and his team started studying FO Aquarii, known as "king of the intermediate polars," a few years ago when NASA's Kepler Telescope was pointed

toward it for three months. The star rotates every 20 minutes, and Garnavich wanted to investigate whether the period was changing.

"I asked Erin Aadland, an REU student, to precisely measure the spin rate of a white dwarf. Does it speed up or slow down?" he said. "We can do that by looking at the interval between flashes from the star just like we use the ticks in a clock to tell time. The star turned out to have other plans for the summer."

Intermediate polars are interesting binary systems because the low-density star drops gas toward the compact dwarf, which catches the matter using its strong magnetic field and funnels it to the surface, a process called accretion. The gas emits X-rays and optical light as it falls, and we see regular light variations as the [stars](#) orbit and spin. Graduate student Mark Kennedy studied the light variations in detail during the three months the Kepler Space Telescope was pointing at FO Aquarii in 2014. Kennedy is a Naughton Fellow from University College, Cork, in Ireland who spent a year and a half working at Notre Dame on interacting binary stars. "Kepler observed FO Aquarii every minute for three months, and Mark's analysis of the data made us think we knew all we could know about this star," Garnavich said.

Once Kepler was pointed in a new direction, Garnavich and his group used the Krizmanich Telescope to continue the study.

"Just after the star came around the sun last year, we started looking at it through the Krizmanich Telescope, and we were shocked to see it was seven times fainter than it had ever been before," said Colin Littlefield, a member of the Garnavich lab. "The dimming is a sign that the donating star stopped sending matter to the compact dwarf, and it's unclear why. Although the star is becoming brighter again, the recovery to normal brightness has been slow, taking over six months to get back to where it was when Kepler observed."

"Normally, the light that we'd see would come from the accretion energy, and it got a lot weaker when the gas flow stopped. We are now following the recovery over months," Garnavich said.

One theory is that a star spot, a cool region on the companion, rotated into just the right position to disrupt the flow of hydrogen from the donating star. But that doesn't explain why the star hasn't then recovered as quickly as it dimmed.

Garnavich and his team also found that the light variations of FO Aquarii became very complex during its low state. The low gas transfer rate had meant the dominant, 20-minute signal had faded and allowed other periods to show up. Instead of a steady 20 minutes between flashes, sometimes there was an 11-minute signal and at other times a 21-minute pulse.

"We had never seen anything like this before," Garnavich said. "For two hours, it would flash quickly and then the next two hours it would pulse more slowly."

The Sarah L. Krizmanich Telescope, installed on the roof of the Jordan Hall of Science in 2013, features a 0.8-meter (32-inch diameter) mirror. It provides undergraduate and graduate students cutting-edge technology for research and is used to test new instrumentation developed in the Department of Physics at Notre Dame.

The Notre Dame team that studied FO Aquarii included Littlefield, Aadland and Kennedy. The team's findings have been published in the *Astrophysical Journal*. Institutions that contributed to the work include The Ohio State University, University Cote d'Azur (France), University de Liege (Belgium) and the American Association of Variable Star Observers (AAVSO).

More information: Colin Littlefield et al. RETURN OF THE KING: TIME-SERIES PHOTOMETRY OF FO AQUARI'S INITIAL RECOVERY FROM ITS UNPRECEDENTED 2016 LOW STATE, *The Astrophysical Journal* (2016). [DOI: 10.3847/1538-4357/833/1/93](https://doi.org/10.3847/1538-4357/833/1/93)

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