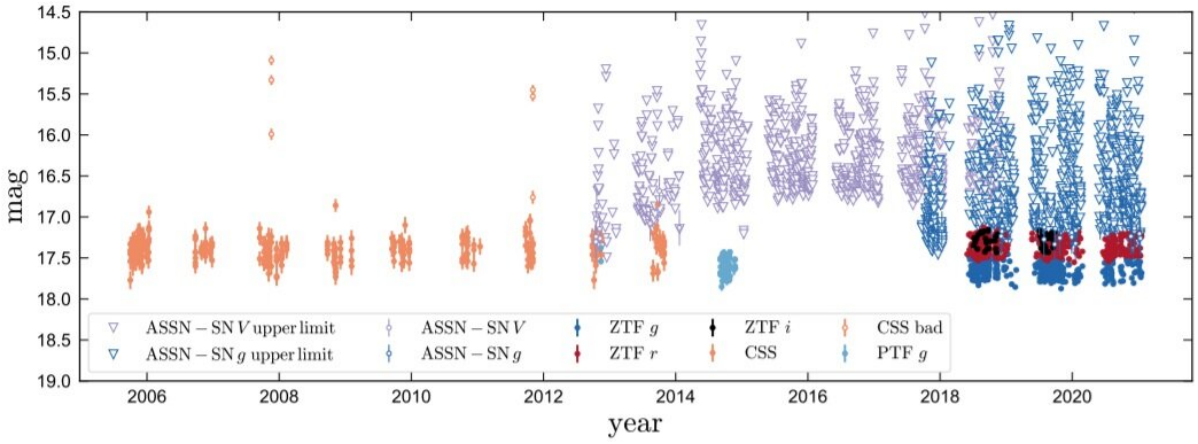
Unusual binary system detected with LAMOST

April 21 2021, by Tomasz Nowakowski



Light curve of J0140, showing data from several time-domain surveys. Credit: El-Badry et al., 2021.

Using the Large Sky Area Multi-Object Fibre Spectroscopic Telescope (LAMOST), astronomers have discovered an unusual binary system. The newly found binary, designated LAMOST J0140355+392651 (or J0140 for short), consists of a bloated, low-mass proto-white dwarf and a massive white dwarf companion. The finding is reported in a paper published April 14 on arXiv.org.

White dwarfs (WDs) are the remaining compact cores of low-mass stars that have exhausted their nuclear fuel. Their atmospheres are mainly composed of hydrogen or helium. Extremely low-mass white dwarfs (ELM WDs) are rare helium-core WDs with masses below 0.25 solar masses. They are degenerate and semi-degenerate helium stars that never ignited core helium burning.

ELM WDs are assumed to be formed in binary systems via stable or unstable mass transfer, given that the universe is too young to produce such objects by single-star evolution. Therefore, it is thought that ELM WDs are the stripped cores of stars that were initially more massive but lost most of their envelope to their companions.

A team of astronomers led by Kareem El-Badry of the University of California Berkeley, now report the detection of J0140 that may be a newly found ELM WD. Its nature first came to their attention when LAMOST observations of this object suggested large epoch-to-epoch radial velocity (RV) variability. Subsequent monitoring of this source allowed the researchers to obtain more information regarding its parameters.

"This paper presents a newly discovered close binary containing a normal white dwarf and a low-mass companion that is nearly or completely Roche lobe filling," the astronomers wrote.

The observations found that J0140 is a close binary with orbital period of approximately 3.81 hours. It contains a bloated, proto-white dwarf with a mass of around 0.15 solar masses and WD companion about 5 percent less massive than the sun. The radius of the proto-WD is estimated to be 0.29 solar radii. The system is located approximately 5,000 light years away and its orbit is inclined 80 degrees.

The astronomers revealed that the proto-WD has an effective

temperature of about 6,800 K, which is much higher than in any known cataclysmic variables (CVs) at similar periods. However, this object is cooler and more bloated when compared to the population of known ELM WDs. Additionally, what disfavors the CV scenario is the lack of outbursts and strong emission lines, typical for such variables.

Hence, the properties of J0140 are transitional between that of known CVs and ELM WDs. The astronomers assume that this system is evolving toward higher temperatures at near-constant luminosity to finally become an ELM WD.

"Further observations are necessary to better understand the nature of the system. In particular, higher-resolution and higher-SNR [signal-to-noise ratio] spectra will allow a deeper search for emission features associated with accretion, which will enable a more conclusive determination of whether there is ongoing mass transfer," the authors of the paper added.

More information: LAMOST J0140355+392651: An evolved cataclysmic variable donor transitioning to become an extremely low mass white dwarf, arXiv:2104.07033 [astro-ph.SR] arxiv.org/abs/2104.07033