Beta Cephei-type pulsations detected in V453 Cygni

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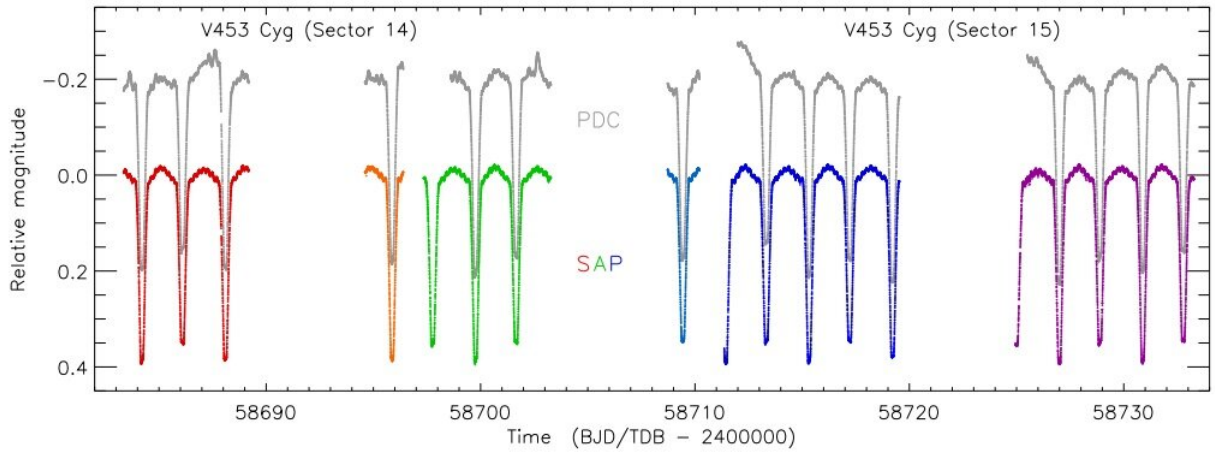

TESS light curve of V453 Cygni. Credit: Southworth et al., 2020.

Using NASA's Transiting Exoplanet Survey Satellite (TESS), astronomers have detected Beta Cephei-type pulsations in an eclipsing binary system known as V453 Cygni. The finding, detailed in a paper published May 15 on arXiv.org, could be helpful in improving the understanding of the structure and evolution of stars in eclipsing binaries.

Beta Cepheids are massive (between 8.0 and 15 solar masses) variable stars with small, rapid variations in their brightness due to pulsations of the stars' surfaces. They pulsate in low-radial order gravity and pressure modes with pulsation periods of several hours and pulsation amplitudes up to a few tenths of a magnitude.

Detecting and studying pulsations is essential to gain more insights into stellar interiors. In particular, studies of pulsating stars in binary systems allow a direct probe of interior rotation and mixing of both components. Moreover, pulsating binary systems have the potential to constrain the effect of tides on stellar structure and evolution.

Located some 6,000 light years away, V453 Cygni is an eclipsing binary consisting of two massive stars of spectral types B0.4 IV and B0.7 IV. The two components are about 14 and 11 times as massive as our sun, in an eccentric short-period orbit (orbital period of approximately 3.89 days).

V453 Cygni was observed with TESS between July 18 and September 11, 2019. By analyzing the data from these observations, a team of astronomers led by John Southworth of Keele University, U.K., found clear signs of line profile variations in the spectra of the system's primary star.

"Using TESS photometry, we have discovered β Cep pulsations in this eclipsing system. Line profile variations in published spectroscopy indicate that these pulsations arise from the primary star," the astronomers wrote in the paper.

In total, the study identified seven significant pulsation frequencies, between 2.37 and 10.51 per day. The pulsations have been attributed to the primary star of V453 Cygni, but the researchers noted that the collected data were not good enough to rule out possible pulsations of

the secondary star.

According to the paper, six of the seven identified pulsation modes were found to be tidally perturbed. The astronomers assume that the tidal torque in V453 Cygni is strong enough to perturb pulsation modes and cause regularity in the amplitude spectrum. This is observed in the form of pulsation frequencies offset from orbital harmonics separated by the orbital frequency.

The TESS data also allowed the team to determine the physical properties of V453 Cygni's components with high precision. It was found that V453 Cygni A has a mass of 13.96 solar masses, radius of 8.66 solar radii and effective temperature at a level of 28,800 K. The secondary star, V453 Cygni B, was estimated to be approximately 5.25 times larger and 11.1 more massive than the sun. The star's effective temperature was calculated to be 27,700 K.

Summing up the results, the astronomers noted that V453 Cygni A is the first Beta Cepheid pulsator with a precise mass measurement. They added that further spectroscopic observations of this system are required in order to definitely confirm the finding that the primary star is pulsating and to check whether the companion is contributing to any of the pulsation frequencies.

More information: Discovery of β Cep pulsations in the eclipsing binary V453 Cygni, arXiv:2005.07559 [astro-ph.SR] arxiv.org/abs/2005.07559