



Rare five star, doubly-eclipsing star system discovered

M. Lohr, Department of Physical Sciences, The Open University, Milton Keynes, United Kingdom (July 2015)

Application Note

Astronomers at the Open University have discovered the first quintuple star system containing two eclipsing binary stars. Details of the five star system, the first of its kind to be found, haven been presented at the UK National Astronomy Meeting at Venue Cymru, Llandudno, Wales [1].

Scientists think that about a third of stars are found in pairs or multiple systems. To find five stars connected to each other though is very rare.

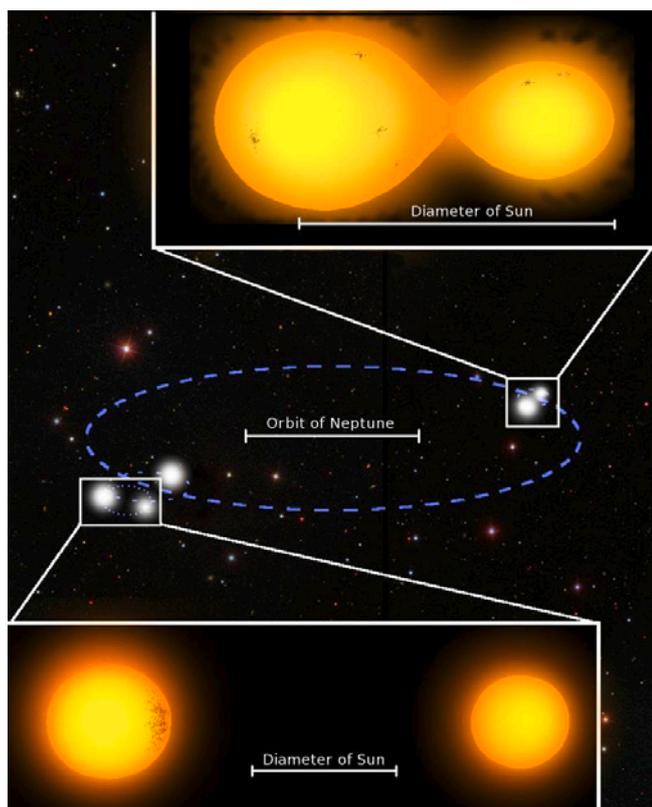
The unusual star system was originally detected in archived data from the SuperWASP [2] (Wide Angle Search for Planets) project, which uses sixteen iKon-L CCD cameras from Andor Technology in the Canary Islands and South Africa to image almost the whole sky every few minutes. Over many years, its measurements of the brightness of individual stars have been assembled into light curves for some 30 million sources in the Milky Way.

Regular small dips in a light curve can reveal the presence of planets orbiting other stars, when they cross or transit the face of their host star, and SuperWASP has been extremely successful in finding these 'exoplanets' since it began operating in 2003. Light curves can also be used to discover eclipsing binary stars, where a pair of stars orbit around their mutual centre of gravity in our line of sight. From the Earth, each star will pass in front of its companion once in every orbit and eclipse some or all of its light. This produces a regular pattern of pairs of dips in the binary's light curve, whose depths and shapes are characteristic of the physical properties of the two stars.

The light curve of the new quintuple system, designated as 1SWASP J093010.78+533859.5, initially revealed the presence of a contact eclipsing binary - a system in which the two stars are orbiting so close together that they share an outer atmosphere. Contact binaries are quite common, but this particular system is notable because its orbital period - the time the two stars take to complete one orbital cycle - is so short, just under six hours. Then it was spotted that the light curve contained some additional unexpected eclipses, and the data were reanalyzed to reveal a second eclipsing binary at the same location on the sky. The new binary is detached - its component stars are well-separated by a distance of about 3 million km, or about twice the size of the Sun - and it has a longer orbital period of one and a third days.

The two sets of stars are separated by about 21 billion km, rather larger than the size of Pluto's orbit around the Sun. The four stars were subsequently observed spectroscopically so that the signatures of the different stars could be studied in detail. This unexpectedly revealed the presence of a fifth star, up to 2 billion km away from the detached binary, but not apparently producing any additional eclipses.

By combining the data from the five stars' light curve and their spectra, the Open University researchers have been able to confirm that they are all gravitationally bound together in a single system, around 250 light years away from us in the constellation of Ursa Major. The data also let the team determine properties of the stars like their masses, sizes and temperatures. All the stars are rather smaller and cooler than our Sun, but the collective system is bright enough (9th magnitude) to be visible in small telescopes and amateur astronomers could see the eclipses for themselves.



An artist's impression of the five star system 1SWASP J093010.78+533859.5. The smaller orbits are not shown to scale relative to the larger orbit, as the binary components would be too close together to distinguish. The inset images are to scale, along with an image of the Sun for comparison. The blue dotted line marks the orbital path of the two pairs of stars. The fifth star, whose position is uncertain, is to the right of the left pair. Credit: Marcus Lohr.

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One particularly interesting finding is that the two binaries seem to be orbiting in the same plane. This suggests that they may have originally formed from a single disk of gas and dust, which broke up as gravity concentrated it into clumps. Studying this bizarre system will help astronomers to better understand how stars and planets, including our own, came into being.

Dr Lohr comments: "This is a truly exotic star system. In principle there's no reason it couldn't have planets in orbit around each of the pairs of stars. Any inhabitants would have a sky that would put the makers of Star Wars to shame. There could sometimes be no fewer than five Suns of different brightness lighting up the landscape. Days would have dramatically varying light levels as the different stars were eclipsed. They would though miss out on night for a large part of their 'year', only experiencing darkness (and a night sky) when the stars were on the same side of their world."



The SuperWASP (Wide Angle Search for Planets) project operates two camera systems – one in La Palma in the Canary Islands and one at Sutherland Observatory, South Africa. These telescopes have a novel optical design comprising eight scientific cameras, each resembling in operation a household digital camera, and collectively attached to a conventional telescope mount. SuperWASP has a field-of-view some 2,000 times greater than a conventional astronomical telescope. The instruments run under robotic control and are housed in their own customized building.

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"Our high-performance scientific cameras play a starring role in this very exciting field of discovery and are proving crucial for many of the leading groups in the field and we are delighted to be playing such a pivotal role," says Colin Duncan, an imaging application specialist at Andor. He adds: "As well as the iKon-L CCD camera used by the pair of hugely-successful SuperWASP telescopes used in this study, custom-designed iKon-L cameras have been chosen for the Next Generation Transit Survey (NGTS) [3] telescope array. This new program has a twelve-strong array of telescopes at the European Southern Observatory in Chile.

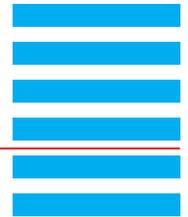
Each telescope is equipped with specially-modified, red-sensitive iKon-L CCD cameras from Andor designed to detect smaller super-Earth exoplanets, demonstrating white noise characteristics to sub-mmag photometric precision. Meanwhile, Kennet Harpsøe's Stellar Observations Network Group (SONG) is building their global network of robotic one-meter telescopes around the ultra-sensitive iXon 897 EMCCD camera (4). And, the groundbreaking improvement in spatial resolution offered by the iXon 897 was also instrumental in Jesper Skottfelt's discovery of two new variable stars in the crowded central region of the globular cluster NGC 6981 (5)."

References

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Conference paper summarises entire research project using SuperWASP to study variable stars

<http://adsabs.harvard.edu/abs/2015ASPC..496...71L>

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