Keele astrophysicist in discovery of red giant and two red dwarfs

Posted on 13 April 2011

A Keele University astrophysicist, John Taylor, is a member of an international group of European, Australian and American researchers who have reported on the discovery of a unique system of stars in a paper published in the Science magazine.

The object, officially labelled HD 181068 but dubbed Trinity by the research team, is one of the brightest stars observed by the NASA Kepler planet-hunting space telescope; at 7th magnitude it is almost visible to the naked eye. Whilst seemingly single, it is in reality a complex triple system in which three stars reside in a very special geometry, showing mutual eclipses as each of the stars passes behind or in front of the others. The most luminous object is a giant star, around which a close pair of two red dwarfs orbits with a period of 45.5 days.

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The discovery of this complex system is exciting because HD 181068 is a real astrophysical laboratory which, unusually for astronomy, is changing so quickly that its evolution can be followed on a human timescale. The red dwarfs are pushing and pulling on the giant star, causing it to pulsate every 11 hours. This in turn seems to have mysteriously suppressed the much smaller and faster pulsations which almost all other giant stars exhibit.

John Taylor was personally responsible for analysis of the data from the Keper satellite, which was difficult due to the huge differences between the three stars. Whilst the giant star is over three times the mass and twelve time the size of the Sun, the two red dwarfs are both smaller and cooler than our Sun and so are hard to detect at all. “This is one of the most challenging objects which I have every worked on,” said John, “ and if it were not for the Kepler satellite we would never even have found the two red dwarf stars in the first place.”

"Thanks to the fortunate viewing angle from Earth, the combined light from the three stars change very characteristically: there are sharp brightness decreases with a period of 0.9 days produced by the mutual eclipses of the close pair of dwarfs, while it takes 2 days for the close pair to pass in front of or behind the red giant" - says Aliz Derekas (Eotvos University and Konkoly Observatory, Budapest, Hungary), the lead author of the paper. A mind-boggling feature of the variations is that when the red dwarfs are in front of the red giant, their short-period eclipses disappear. “This is because the surface brightnesses of the three stars are actually very similar, and just as a white rabbit cannot be seen in snow-fall, the red dwarfs in front of the red giant are also almost invisible, hence no light is lost when they eclipse each other.”

The authors discovered this interesting system in June 2010 and had to obtain additional ground-based observations to help interpret the nature of the object. "The spectroscopic measurements

revealed the periodic motion of the largest star in the system with the wide orbital period of 45.5 days. The 2-day long eclipses are so similar at first sight that we thought that the outer orbital period is 22.7 days. Only after having obtained the whole radial velocity curve, we realised the tiny differences in the long period minima and that the real period was actually double this.' says Laszlo Kiss (Konkoly Observatory), the second author of the paper.

Further observations using interferometry were used to measure the angular size of the red giant. "Combining the angular diameter with the known distance of the system we were able to measure the absolute radius of the red giant, which was a great achievement given its large distance of 800 light years" - adds Daniel Huber (University of Sydney, Australia), who led the interferometric observations using the Center for High-Angular Resolution Astronomy (CHARA) at Mount Wilson Observatory in California, USA.