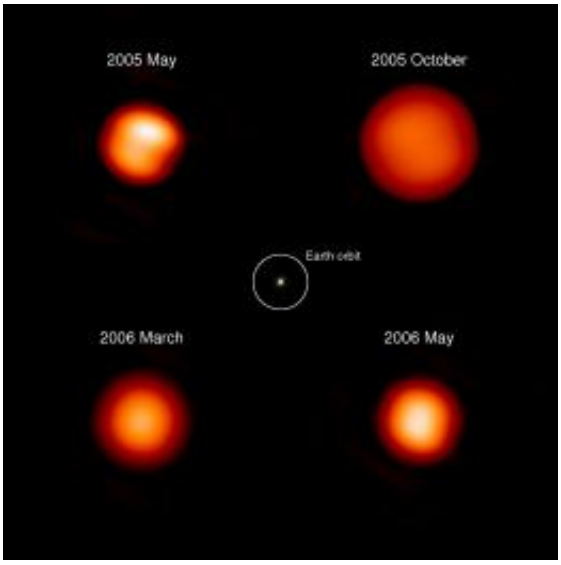
A New Method of Estimating Stellar Distances

December 21 2009



A false color image of the pulsating red giant star Chi Cygni, as imaged in the infrared by the Infrared Optical Telescope Array. Four different times of the pulsation are shown, and hot spots on the star's surface can be seen. At its smallest, the star's diameter is about 300 million miles. Credit: IOTA, and Lacour et al., 2009

(PhysOrg.com) -- The star Chi Cygni is located about 550 light-years away, in the direction of the constellation of Cygnus the Swan. It is a notable star because, unlike the sun which still burns hydrogen and is in its mature phase of life, Chi Cygni has aged and begun to expire.

One general feature of stellar aging is that a star's size begins to swell,

and if Chi Cygni were located at the sun's position it would by now have swallowed all the planets in our solar system out to Mars. These kinds of stars are called red giants. Our sun will enter a similar phase of life in another eight billion years or so, and research into red giants opens a window onto the fate of our sun and the earth.

Studies of Chi Cygni have found that not only has the radius expanded, it has begun to pulse dramatically in size. SAO astronomer Marc Lacasse and a team of fifteen colleagues used the Smithsonian's Infrared Optical Telescope Array (IOTA, now retired from operation) on Mt. Hopkins, AZ, to obtain for the first time close-up images of the surface of Chi Cygni that show the star beating like a giant heart. As it pulses, once every 408 days, it puffs off its outer layers; in a few hundred thousand years it will create a beautifully gleaming planetary nebula.

At its smallest, when its diameter is about 300 million miles, the star's surface becomes mottled with brilliant spots as massive plumes of hot plasma roil its surface. (These spots are like the granules on our sun's surface, but much larger.) Then, as it expands, Chi Cygni cools and dims, swelling to a diameter of 480 million miles. The new images are like a stop-motion movie of a pulsating star, and show that the pulsation is not only radial, but comes with inhomogeneities, for example, a giant hotspot that appeared.

Imaging variable stars is extremely difficult -- all stars (besides the sun) are so far away that their apparent size is tiny, requiring very specialized techniques to be measured accurately. Variable, red giants like Chi Cygni have an additional problem - a compact, dense shell of dust and molecules around the star that obscures visible light. The IOTA facility circumvented both of these difficulties by observing the star with these techniques at infrared wavelengths, where the effects of dust are much less severe.

IOTA obtained images about fifteen times sharper than possible with the the Hubble Space Telescope. The new results have enabled astronomers to derive an improved estimate of the star's mass, luminosity, and distance, and since the period of variability appears to be directly related to the luminosity, the hope is that further research into other, similar variable stars will provide a new means of calibrating the distances to stars whose period and luminosity can be precisely measured.

Provided by Harvard-Smithsonian Center for Astrophysics