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'Bullet star' shines 350 times brighter than the sun

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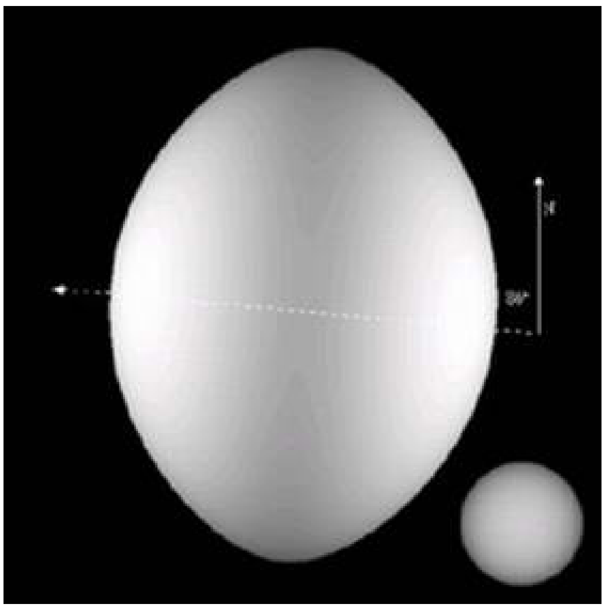

For decades, scientists have observed that Regulus, the brightest star in the constellation Leo, spins much faster than the sun. But thanks to a powerful new telescopic array, astronomers now know with unprecedented clarity what that means to this massive celestial body.

Image: Regulus and the sun are shown as they would appear side by side. The diameter of Regulus at its equator is 4.2 times that of the sun. The dashed line identifies the spin axis of the star, and the 86 degree tilt of the *pole from the north is indicated. The phenomenon of "gravity darkening" is responsible for Regulus being brighter at its poles than around its equator. The picture of Regulus is based upon measurements obtained with the CHARA array, which does not by itself produce a true image of the star.*

A group of astronomers, led by Hal McAlister, director of Georgia State University's Center for High Angular Resolution Astronomy, have used the center's array of telescopes to detect for the first time Regulus' rotationally induced distortions. Scientists have measured the size and shape of the star, the temperature difference between its polar and equatorial regions, and the orientation of its spin axis. The researchers' observations of Regulus represent the first scientific output from the CHARA array, which became routinely operational in early 2004.

Most stars rotate sedately about their spin axes, McAlister says. The sun, for example, completes a full rotation in about 24 days, which means its equatorial spin speed is roughly 4,500 miles per hour. Regulus' equatorial spin speed is nearly 700,000 miles per hour and its diameter is about five times greater than the sun's. Regulus also bulges conspicuously at its equator, a stellar rarity.

Regulus' centrifugal force causes it to expand so that its equatorial diameter is one-third larger than its polar diameter. In fact, if Regulus were rotating about 10 percent faster, its outward centrifugal force would exceed the inward pull of gravity and the star would fly apart, says McAlister, CHARA's director and Regents Professor of Astronomy at Georgia State.

Because of its distorted shape, Regulus, a single star, exhibits what is known as "gravity darkening" – the star becomes brighter at its poles than at its equator -- a phenomenon previously only detected in binary stars. According to McAlister, the darkening occurs because Regulus is colder at its equator than at its poles. Regulus' equatorial bulge diminishes the pull of gravity at the equator, which causes the temperature there to decrease. CHARA researchers have found that the temperature at Regulus' poles is 15,100 degrees Celsius, while the equator's temperature is only 10,000 Celsius. The temperature variation causes the star to be about five times brighter at its poles than at its equator. Regulus' surface is so hot that the star is actually nearly 350 times more luminous than the sun.

CHARA researchers discovered another oddity when they determined the orientation of the star's spin axis, says McAlister.

"We're looking at the star essentially equator-on, and the spin axis is tilted about 86 degrees from the north direction in the sky," he says. "But, curiously enough, the star is moving through space in the same direction its pole is pointing. Regulus is moving like an enormous spinning bullet through space. We have no idea why this is the case."

Astronomers viewed Regulus using CHARA's telescopes for six weeks last spring to obtain interferometric data that, combined with spectroscopic measurements and theoretical models, created a picture of the star that reveals the effects of its incredibly fast spin. The results will be published this spring in The Astrophysical Journal.

The CHARA array, located atop Mt. Wilson in southern California, is among a handful of new "super" instruments composed of multiple telescopes optically linked to function as a single telescope of enormous size. The array consists of six telescopes, each containing a light-collecting mirror one meter in diameter. The telescopes are arranged in the shape of a "Y," with the outermost telescopes located about 200 meters from the center of the array.

A precise combination of the light from the individual telescopes allows the CHARA array to behave as if it were a single telescope with a mirror 330 meters across. The array can't show very faint objects detected by telescopes such as the giant 10-meter Keck telescopes in Hawaii, but scientists can see details in brighter objects nearly 100 times sharper than those obtainable using the Keck array. Working at infrared wavelengths, the CHARA array can see details as small as 0.0005 arcseconds. (One arcsecond is 1/3,600 of a degree, equivalent to the angular size of a dime seen from a distance of 2.3 miles.) In addition to Georgia State researchers, the CHARA team includes collaborators from the National Optical Astronomy Observatories in Tucson, Ariz., and NASA's Michelson Science Center at the California Institute of Technology in Pasadena.

Source: Georgia State University

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