University of Michigan astronomers capture the first image of surface features on a sun-like star

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University of Michigan astronomers combined light from four widely separated telescopes to produce the first picture showing surface details on a sun-like star beyond our solar system.

The image of the rapidly rotating, hot star Altair is the most detailed stellar picture ever made using an innovative light-combining technique called optical interferometry, said U-M astronomer John Monnier.

Beyond this technical milestone, the Altair observations provide surprising new insights that will force theorists to revise ideas about the behavior of rapid rotators like Altair.

"This powerful new tool allows us to zoom in on a star that's a million times farther away than the sun," said Monnier, lead author of a paper to be published online Thursday by the journal Science. "We're testing the theories of how stars work in much more detail than ever before."

Monnier and U-M graduate student Ming Zhao led an international team that made the Altair observations using four of the six telescopes at Georgia State University's Center for High Angular Resolution Astronomy (CHARA) interferometric array on Mount Wilson, Calif.

The four telescopes were separated by nearly 300 yards. Vacuum tubes carried starlight from the four scopes to a U-M built device called the Michigan Infrared Combiner, known as MIRC.

The combiner allowed researchers to merge infrared light from four of CHARA's telescopes for the first time, simulating a single giant instrument three football fields across. The result was an image of unprecedented detail---roughly 100 times sharper than pictures from the Hubble Space Telescope.

While solar astronomers can view sunspots and storms on our home star's roiling surface in exquisite detail, most other stars have---until very recently---appeared as simple points of light through even the most powerful telescopes.

But in the past decade, advances in the emerging field of optical interferometry have launched a new era of stellar imaging.

Other research teams have used the technique to acquire surface images of giant stars hundreds of times bigger than Altair. But the U-M-led study provides the first picture of a so-called main sequence star, one that generates energy mainly from hydrogen-to-helium nuclear fusion reactions in its core. Main sequence stars include the sun and most of the stars we see in the night sky.

"This is just a monumental stepping stone for us," said Harold McAlister, director of CHARA and a regent's professor of astronomy at Georgia State University in Atlanta. "Main sequence stars are far and away the largest population of stars out there, and being able to make a picture of one creates tremendous opportunities for future research."

One likely target for future studies: Imaging planets around stars beyond our solar system, said U-M's Zhao. "Imaging stars is just the start," he said.

Altair is the brightest star in the constellation Aquila, The Eagle, and is clearly visible with the naked eye in Northern Hemisphere skies. The nearby star is hotter and younger than the sun and nearly twice its size. Altair rotates at 638,000 mph at its equator, roughly 60 times faster than our home star.

"It's really whipping around and that's why, of

course, it's spread out like a twirling ball of pizza dough," said Monnier, an assistant professor of astronomy.

Previous studies revealed that Altair, unlike most stars, is not a perfect sphere. Instead, its rapid spin rate creates centrifugal forces that flatten it into an oval: Its radius is significantly larger at the equator than at the poles.

In 1924, astronomer Hugo von Zeipel predicted that rapid rotators would display just this type of equatorial bulge. He also surmised that these stars would sport a dark band along the equator called gravity darkening. The bloated equator would appear dark because it is farther from the star's fiery nuclear core, and therefore cooler than the poles.

The CHARA picture of Altair, the result of observations made on two nights last summer, is "the first image of a star that allows us to visually confirm that basic idea" of gravity darkening, Monnier said. But the Altair image displays even more equatorial darkening than standard models predict, pointing to flaws in current models, he said.

Source: University of Michigan