Research investigates the brightest star of 47 Tucanae

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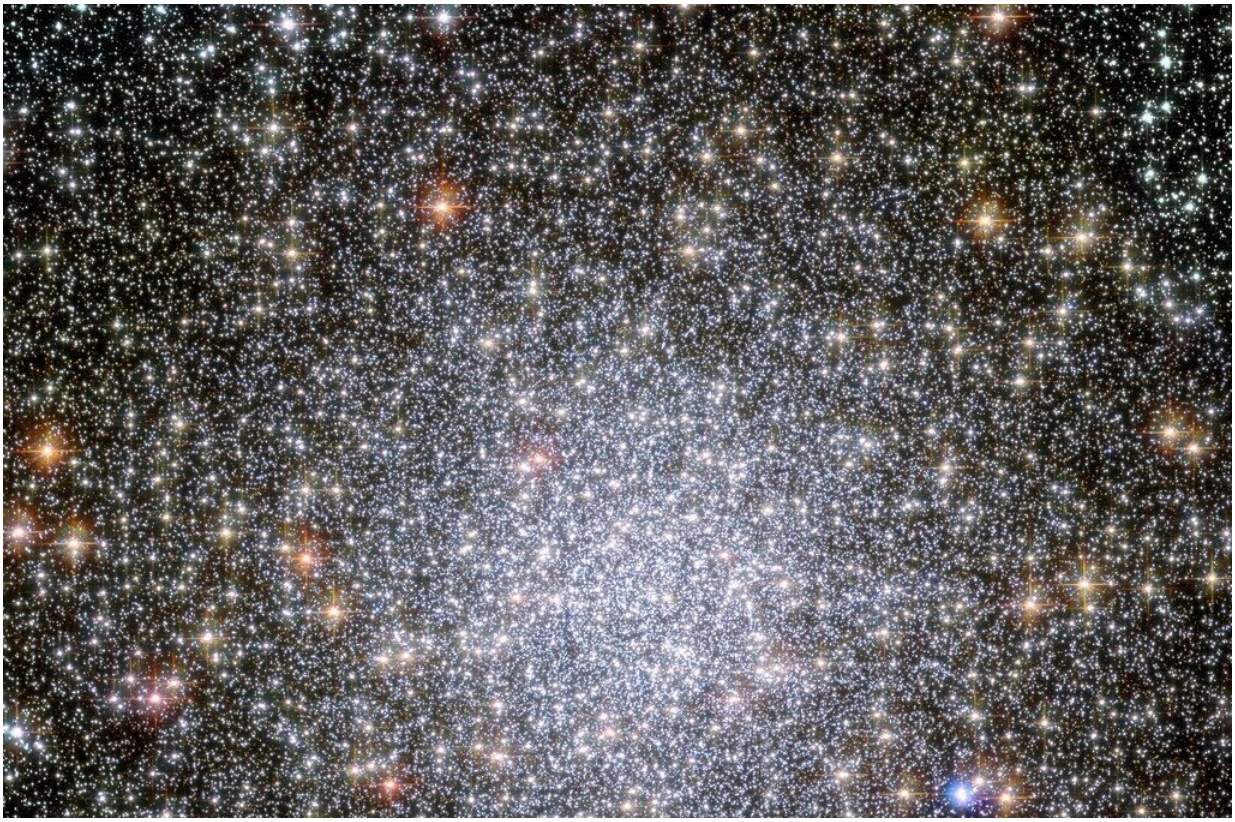

Globular cluster 47 Tucanae. Credit: NASA, ESA, and the Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration.

Astronomers have inspected the brightest star of a globular cluster known as 47 Tucanae (other designation NGC 104). Results of the study,

published August 3 on arXiv.org, provide important insights into the properties and chemical composition of this star, what could improve our understanding of the cluster's nature.

Globular clusters (GCs) are collections of tightly bound stars orbiting galaxies. Astronomers perceive them as natural laboratories enabling studies on the evolution of stars and galaxies. In particular, globular clusters could help researchers better understand the formation history and evolution of early type galaxies, as the origin of GCs seems to be closely linked to periods of intense star formation.

Located some 13,000 light years away in the constellation Tucana, 47 Tucanae, or 47 Tuc for short, is a globular cluster with a diameter of about 120 light years. It is the second brightest GC in the sky and can be seen with the naked eye.

The brightest star of 47 Tuc at both ultraviolet and optical wavelengths is the so-called "Bright Star" (BS). It is a blue giant star of spectral type B8 III with an effective temperature of some 11,000 K. Moreover, the Bright Star is a post-asymptotic giant branch (post-AGB) star that is moving across the color-magnitude diagram toward the tip of the white-dwarf cooling sequence.

Although many studies of the bright star have been conducted, its chemical composition is still poorly understood. Given that the Bright Star represents a unique window into the chemistry of 47 Tuc, a team of astronomers led by William V. Dixon of the Space Telescope Science Institute in Baltimore, Maryland, investigated this star using the Far Ultraviolet Spectroscopic Explorer (FUSE), the Hubble Space Telescope (HST) and the Magellan Telescope.

The observations allowed the team to determine photospheric abundances of 26 elements of the bright star. The data show that the

intermediate-mass elements generally scale with iron, while the heaviest elements have roughly solar abundances. It was found that the star has a relatively low carbon to nitrogen ratio, what suggests that it belongs to the second generation of cluster stars. Moreover, it turns out to have also a low carbon-to-oxygen ratio, indicating that it did not undergo third dredge up on the AGB.

The study determined the fundamental parameters of the bright star. According to the research, it has a radius of about 9.63 solar radii, mass of approximately 0.54 solar masses, and effective temperature at a level of 10,850 K. The derived mass of the bright star suggests that single stars in 47 Tuc lose between 0.1–0.2 solar masses on the AGB, which is only slightly lower than the mass the same stars lose on the red giant branch (RGB).

Summing up the results, the researchers concluded that the bright star experienced no significant change in its photospheric abundances as it climbed the AGB.

"If so, then its heavy-element abundances are typical of the cluster values," the authors of the paper added.

More information: William V. Dixon et al, Observations of the Bright Star in the Globular Cluster 47 Tucanae (NGC 104), arXiv:2108.01641 [astro-ph.SR] arxiv.org/abs/2108.01641