Newly-discovered star could provide new insights into the evolution of stars

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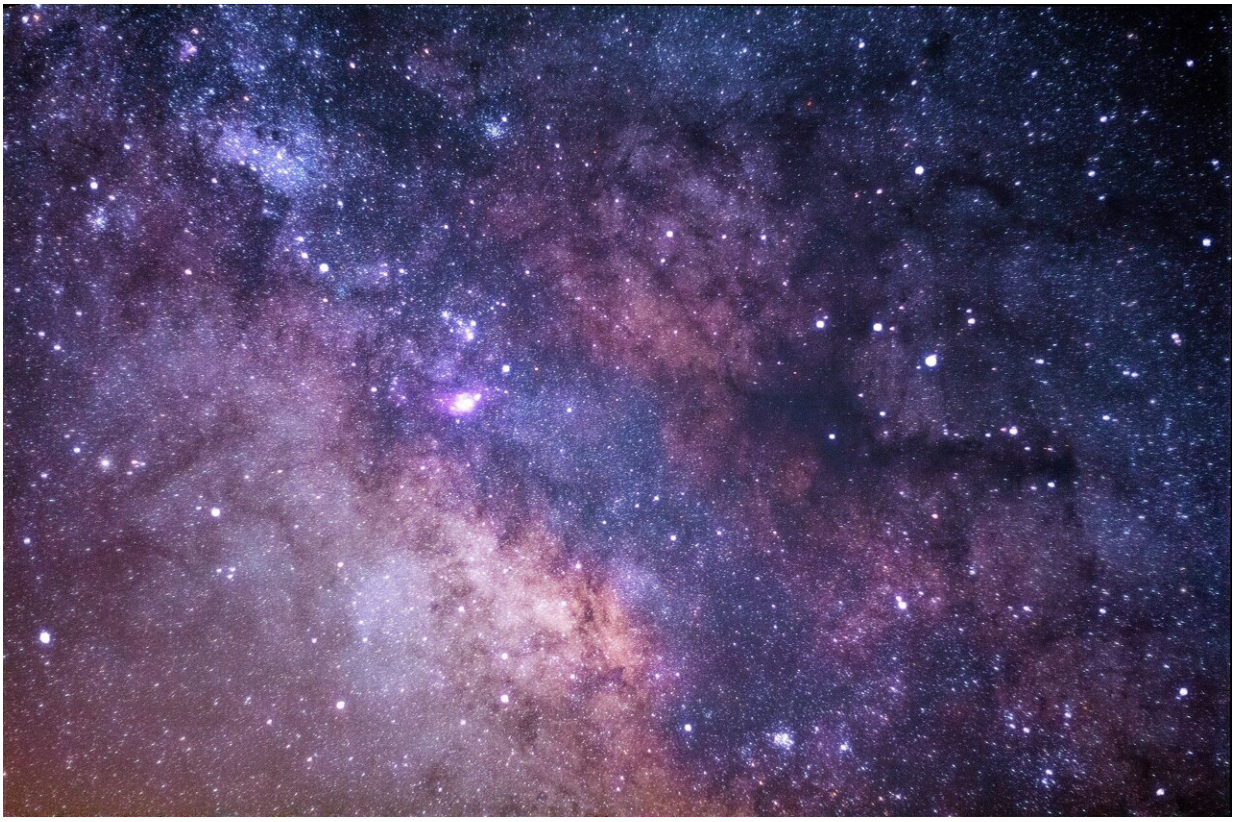

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A new study published in *The Astrophysical Journal*, led by Assistant Professor of Astronomy Rana Ezzeddine and UF alumnus Jeremy Kowkabany, with collaborators, reports the discovery of a star that

challenges astronomers' understanding of star evolution and formation of chemical elements, and could suggest a new stage in their growth cycle.

It is widely accepted that as stars burn, they lose lighter elements like lithium in exchange for heavier elements like carbon and oxygen, but an analysis of this new star revealed that not only was its lithium content high for its age, but was higher than the normal level for any star at any age.

This star, named J0524-0336 based on its coordinates in space, was discovered recently by Ezzeddine as part of a different study that used surveying to look for older stars in the Milky Way. It is an evolved star, meaning that it is in the later stages of its "life" and is beginning to grow unstable. That also means that it is much larger and brighter than most other stars of its type, estimated to be about 30 times the size of the sun.

To measure J0524-0336's elemental composition, Ezzeddine's team used a method called spectroscopy. A spectrograph latches onto a telescope and filters the star's light into its constituent rainbows. Dark spots on this spectrum can be used to determine how much of an element constitutes the star.

"We found that J0524-0336 contains 100,000 times more lithium than the sun does at its current age," said Ezzeddine. "This amount challenges the prevailing models of how stars evolve and may suggest a previously unknown mechanism for lithium production or retention in stars."

The team came up with a few potential hypotheses to explain J0524-0336's high lithium content. It could be in an as-of-yet unobserved phase in the evolutionary cycle of stars, or it may have gained the element from a recent interaction with another celestial body. Stars as old and as large as this one have been theorized to absorb nearby planets and neighboring stars as they age, so J0524-0336 may have

simply picked up another lithium-rich body and hasn't had a chance to fuse the matter. Ezzeddine believes that with the amount of lithium found in J0524-0336, it is likely that there might have been contributions from both hypotheses, but more work is needed to reach conclusions.

Ezzeddine and Kowkabany, now a graduate student at FSU, and their collaborators, plan to conduct more studies on J0524-0336. They hope to use a continuous monitoring program to track the star's compositional changes over time and to observe different wavelengths, such as infrared light and radio waves, to see if any material is being ejected from the star.

"If we find a build-up of dust in the star's circumstellar disk, or the ring of debris and materials being ejected from the star, this would clearly indicate a mass loss event, such as a stellar interaction," Ezzeddine explained. "If we don't observe such a disk, we could conclude that the lithium enrichment is happening due to a process, still to be discovered, taking place inside the star instead."

More information: Jeremy Kowkabany et al, Discovery of an Ultra Lithium-rich Metal-Poor Red Giant star, *arXiv* (2022). DOI: 10.48550/arxiv.2209.02184

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