# Discovered: Remnant of ancient globular cluster that's 'the last of its kind'

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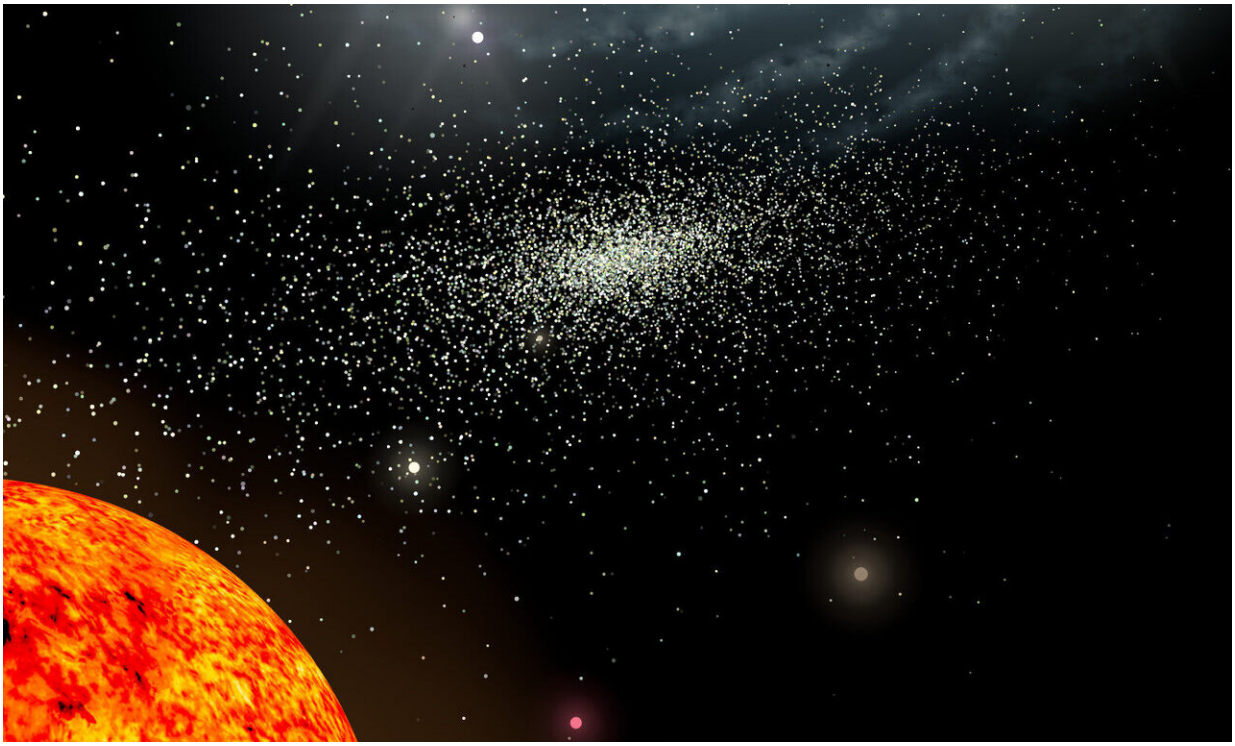


An artist's representation of the Phoenix Stellar Stream. Originally a ball of stars, known as a globular cluster, Phoenix has been stretched into a stream of stars by the gravitational pull of the Milky Way. In a few billion years, Phoenix will be completely destroyed and absorbed into our galaxy. Credit: Geraint F. Lewis and the S5 collaboration.

A team of astronomers including Carnegie's Ting Li and Alexander Ji

discovered a stellar stream composed of the remnants of an ancient globular cluster that was torn apart by the Milky Way's gravity 2 billion years ago, when Earth's most-complex lifeforms were single-celled organisms. This surprising finding, published in *Nature*, upends conventional wisdom about how these celestial objects form.

Imagine a sphere made up of a million stars bound by gravity and orbiting a galactic core. That's a globular cluster. The Milky Way is home to about 150 of them, which form a tenuous halo that envelops our galaxy.

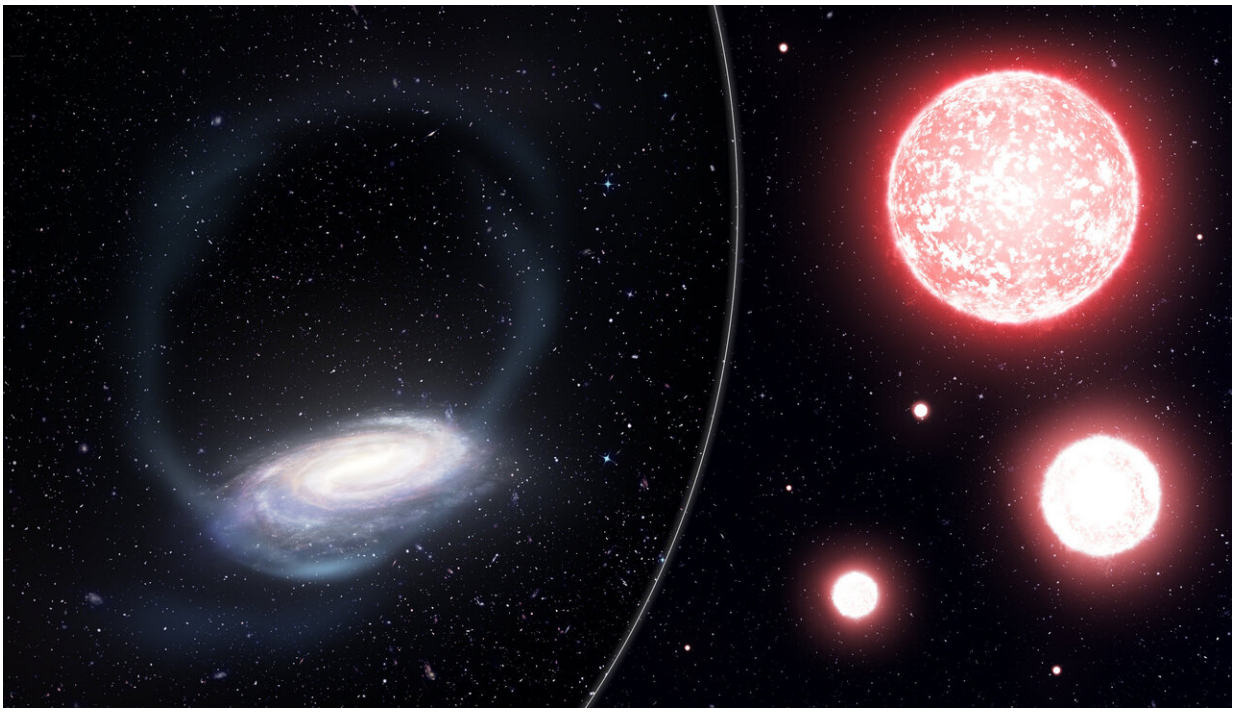
But the globular cluster that spawned this newly discovered stellar stream had a lifecycle that was very different from the globular clusters we see today.

"This is stellar archeology, uncovering the remnants of something ancient, swept along in a more-recent phenomenon," explained Ji.

Using the Anglo-Australian Telescope, the stream was revealed by S5, the Southern Stellar Stream Spectroscopic Survey Collaboration. Led by Li, the initiative aims to map the motion and chemistry of stellar streams in the Southern Hemisphere.

In this study, the collaborative focused on a stream of stars in the Phoenix constellation.

"The globular cluster remnants that make up the Phoenix Stream were disrupted many billion years ago, but luckily retain the memory of its formation in the very early universe, which we can read from the chemical composition of its stars," said Li



An artist's impression of the thin stream of stars torn from the Phoenix globular cluster, wrapping around our Milky Way (left). For the study, the astronomers targeted bright Red Giant stars, to measure the chemical composition of the disrupted Phoenix globular cluster (right). Credit: James Josephides (Swinburne Astronomy Productions) and the S5 Collaboration.

The team measured the abundances of heavier elements—what astronomers call a star's metallicity.

A star's makeup mirrors that of the cloud of galactic gas from which it is born. The more prior generations of stars have seeded this material with heavy elements that they produced during their lifetimes, the more enriched, or metallic, the stars are said to be. Therefore, a very ancient, primitive star, will have almost no heavy elements.

"We were really surprised to find that the Phoenix Stream is distinctly

different to all of the other globular clusters in the Milky Way," explained lead author Zhen Wan of the University of Sydney. "Even though the cluster was destroyed billions of years ago, we can still tell it formed in the early universe."

Because other known globular clusters are enriched by the presence of heavy elements forged by stellar earlier generations, it was theorized that there was a minimum abundance of heavier elements required for a globular cluster to form.

But the Phoenix Stream progenitor is well below this predicted minimum metallicity, posing a significant problem for previous ideas about how globular clusters are born. "One possible explanation is that the Phoenix Stream represents the last of its kind, the remnant of a population of globular clusters that was born in radically different environments to those we see today," Li said.

The researchers proposed that these no-longer-with-us globular clusters were steadily depleted by the Milky Way's gravitational forces, which tore them to pieces. The remnants of other ancient globular clusters may also live on as faint streams that can still be discovered before they dissipate over time.

"There is plenty of theoretical work left to do, and there are now many new questions for us to explore about how galaxies and globular clusters form," said co-author Geraint Lewis, also of the University of Sydney.

**More information:** The tidal remnant of an unusually metal-poor globular cluster, *Nature* (2020). DOI: 10.1038/s41586-020-2483-6 , www.nature.com/articles/s41586-020-2483-6

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