350,000 stars' DNA interrogated in search for sun's lost siblings

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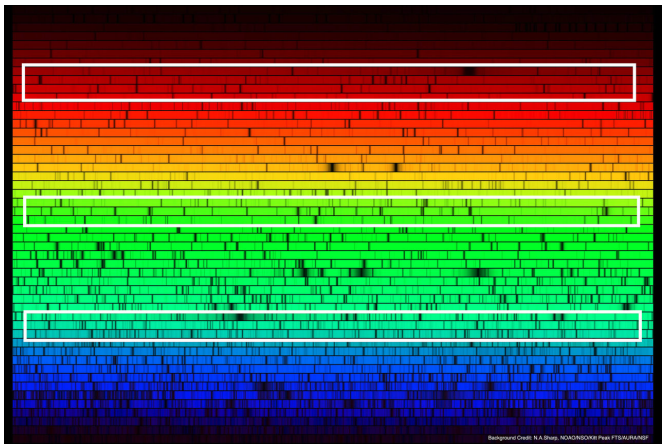


HERMES, the new spectrograph built at the AAO, uses volume phase holographic (VPH) gratings to provide various optimized spectra in blue, green and red light and a fourth band in infra-red light. HERMES spectra allows astronomers to study the chemical makeup of stars to understand their formation and evolution. A spectrum of the Sun shows many dark features because of various chemical elements in sunlight. Credit: N.A. Sharp, NOAO/NSO/Kitt Peak FTS/AURA/NSF.

An Australian-led group of astronomers working with European collaborators has revealed the "DNA" of more than 340,000 stars in the Milky Way, which should help them find the siblings of the Sun, now scattered across the sky.

This is a major announcement from an ambitious Galactic Archaeology survey, called GALAH, launched in late 2013 as part of a quest to uncover the formulation and evolution of galaxies. When complete, GALAH will investigate more than a million stars.

The GALAH survey used the HERMES spectrograph at the Australian Astronomical Observatory's (AAO) 3.9-metre Anglo-Australian Telescope near Coonabarabran, NSW, to collect spectra for the 340,000 stars.

The GALAH Survey today makes its first major public data release.

The 'DNA' collected traces the ancestry of stars, showing astronomers how the Universe went from having only hydrogen and helium - just after the Big Bang - to being filled today with all the elements we have here on Earth that are necessary for life.

"No other survey has been able to measure as many elements for as many stars as GALAH," said Dr Gayandhi De Silva, of the University of Sydney and AAO, the HERMES instrument scientist who oversaw the groups working on today's major data release.

"This data will enable such discoveries as the original star clusters of the Galaxy, including the Sun's birth cluster and solar siblings - there is no other dataset like this ever collected anywhere else in the world," Dr De Silva said.

Dr. Sarah Martell from the UNSW Sydney, who leads GALAH survey observations, explained that the Sun, like all stars, was born in a group or cluster of thousands of stars.

"Every star in that cluster will have the same chemical composition, or DNA - these clusters are quickly pulled apart by our Milky Way Galaxy and are now scattered across the sky," Dr Martell said.

"The GALAH team's aim is to make DNA matches between stars to find their long-lost sisters and brothers."

For each star, this DNA is the amount they contain of each of nearly two dozen chemical elements such as oxygen, aluminium, and iron.

Unfortunately, astronomers cannot collect the DNA of a star with a mouth swab but instead use the

starlight, with a technique called spectroscopy.

The light from the star is collected by the telescope and then passed through an instrument called a spectrograph, which splits the light into detailed rainbows, or spectra.

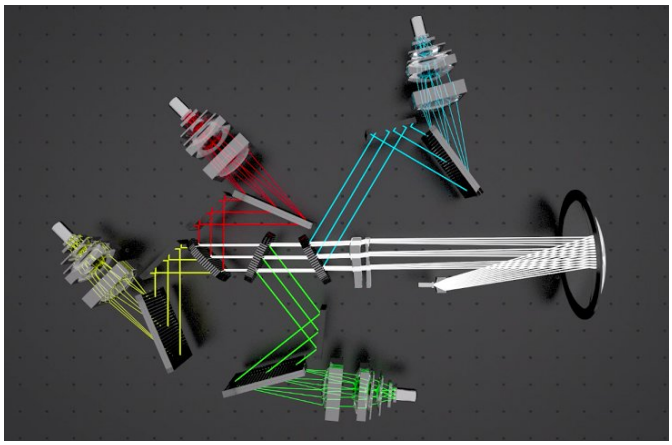
Associate Professor Daniel Zucker, from Macquarie University and the AAO, said astronomers measured the locations and sizes of dark lines in the spectra to work out the amount of each element in a star.

"Each chemical element leaves a unique pattern of dark bands at specific wavelengths in these spectra, like fingerprints," he said.

Dr Jeffrey Simpson of the AAO said it takes about an hour to collect enough photons of light for each star, but "Thankfully, we can observe 360 stars at the same time using fibre optics," he added.

The GALAH team has spent more than 280 nights at the telescope since 2014 to collect all the data.

The GALAH survey is the brainchild of Professor Joss Bland-Hawthorn from the University of Sydney and the ARC Centre of Excellence for All Sky Astrophysics in 3 Dimensions (ASTRO 3D) and Professor Ken Freeman of the Australian National University (ANU). It was conceived more than a decade ago as a way to unravel the history of our Milky Way galaxy; the HERMES instrument was designed and built by the AAO specifically for the GALAH survey.



A schematic of the HERMES instrument showing the light path of how star light from the telescope AAT is split into four different channels. Credit: The Australian Astronomical Observatory (AAO)

Measuring the abundance of each chemical in so many stars is an enormous challenge. To do this, GALAH has developed sophisticated analysis techniques.

PhD student Sven Buder of the Max Planck Institute for Astronomy, Germany, who is lead author of the scientific article describing the GALAH data release, is part of the analysis effort of the project, working with PhD student Ly Duong and Professor Martin Asplund of ANU and ASTRO 3D.

Mr. Buder said: "We train [our computer code] The Cannon to recognize patterns in the spectra of a subset of stars that we have analysed very carefully, and then use The Cannon's machine learning algorithms to determine the amount of each element for all of the 340,000 stars." Ms. Duong noted that "The Cannon is named for Annie Jump Cannon, a pioneering American astronomer who classified the spectra of around 340,000 stars by eye over several decades a century ago - our code analyses that many stars in far greater detail in less than a day."

The GALAH survey's data release is timed to coincide with the huge release of data on 25 April from the European Gaia satellite, which has mapped more than 1.6 billion stars in the Milky Way - making it by far the biggest and most accurate atlas of the night sky to date.

In combination with velocities from GALAH, Gaia data will give not just the positions and distances of the stars, but also their motions within the Galaxy.

Professor Tomaz Zwitter (University of Ljubljana, Slovenia) said today's results from the GALAH survey would be crucial to interpreting the results from Gaia: "The accuracy of the velocities that we are achieving with GALAH is unprecedented for such a large survey."

Dr Sanjib Sharma from the University of Sydney concluded: "For the first time we'll be able to get a detailed understanding of the history of the Galaxy."

Provided by University of Sydney