WEBB UNCOVERS GALAXIES IN THE EARLY COSMOS p. 36

SEPTEMBER 2024

The world's best-selling astronomy magazine

ECCLIPSE

Complete field reports from the sky event of the year! p.14



THE ANDROMEDA GALAXY IN MANY COLORS p. 24 HOW TO CREATE PRO IMAGES FROM WEBB DATA p. 38 THIS MONTH'S GREATEST CELESTIAL EVENTS p. 28 SECRETS TO SUCCESSFUL AUTOGUIDING p. 42 www.Astronomy.com



EXPLORING A CLUSTER CONUNDRUM

JWST probes the multiple generations of stars in globular cluster NGC 6440. BY RICHARD TALCOTT

DESPITE WHAT SOME JADED

AMATEUR astronomers might claim, not all globular clusters are alike. Sure, they all contain 100,000 or more stars held together by mutual gravity and packed into a tight sphere. And those in the Milky Way, at least, all date back to the galaxy's early days.

But the similarities end there. Many globular clusters show evidence of multiple stellar populations, meaning not all their stars formed at the same time. And though every cluster possesses a higher percentage of hydrogen and helium than do stars like the Sun, some of them have surprisingly elevated levels of heavier elements (what astronomers call metals).

A RARE CLUSTER

To better understand how globular clusters formed and evolved, researchers turned the powerful eye of the James Webb Space Telescope (JWST) on NGC 6440. This cluster

Although this Hubble Space Telescope view of NGC 6440 looks stunning in its own right, it doesn't resolve as many stars as JWST. NASA, ESA, C. PALLANCA AND F. FERRARO (UNIVERSITY OF BOLOGNA), AND M. VAN KERKWUK (UNIVERSITY OF TORONTO) lies in western Sagittarius just 1° from that constellation's border with Scorpius. The stars within NGC 6440 are an average of 1 light-year apart, though near the center they crowd within a few lightdays of one another. And the cluster lies about 28,000 light-years from Earth but only 4,000 light-years from the Milky Way's center.

This places NGC 6440 firmly within the galactic bulge, a roughly spherical collection of old stars about



12,000 light-years across that's centered on the galaxy's heart. Although about 150 globulars call the Milky Way home, only 15 or so reside in the bulge. The rest occupy the much larger halo, which stretches beyond the galaxy's broad disk.

Bulge globulars are particularly significant because they contain more metals than their halo cousins. But their location within the bulge makes them difficult to observe. Thick dust both obscures the view into this region and

reddens the starlight that does pass through. The crowded central regions of the galaxy also contaminate the scene with an abundance of noncluster members.

While visible-light telescopes struggle with these challenges, JWST shines. Its 6.5-meter mirror provides a resolution high enough to separate individual stars within the congested cluster environment. And the near-infrared radiation JWST detects passes through dust relatively unscathed.

CLUSTER CLOSE-UP

A team of astronomers led by Mario Cadelano of the University



of Bologna in Italy targeted NGC 6440 with JWST's Near-Infrared Camera. Using two of the camera's filters, the scientists plotted a color-magnitude diagram (also known as a Hertzsprung-Russell diagram) that included more than 10,000 cluster members. Because different abundances of light elements affect a star's temperature (color) and luminosity (magnitude), these diagrams can separate stars with subtle compositional differences. The researchers distinguished two noteworthy variations along the cluster's main sequence, where stars spend most of their lives converting hydrogen into helium. The brighter stars showed a pronounced split in the quantity of helium in their atmospheres, while dimmer ones revealed an equally strong divide in the abundance of water, a molecule that exists in the atmospheres of cool red dwarfs and traces the amount of oxygen. The findings confirm that NGC 6440 experienced multiple bouts of star formation in its earliest days. And the unique ability of JWST to explore these different episodes in the realm of the galactic bulge opens a new frontier in exploring the composition, birth, and evolution of these enigmatic globular clusters.

Contributing Editor **Richard Talcott** wrote about JWST's contribution to the ongoing Hubble tension debate in the August issue.