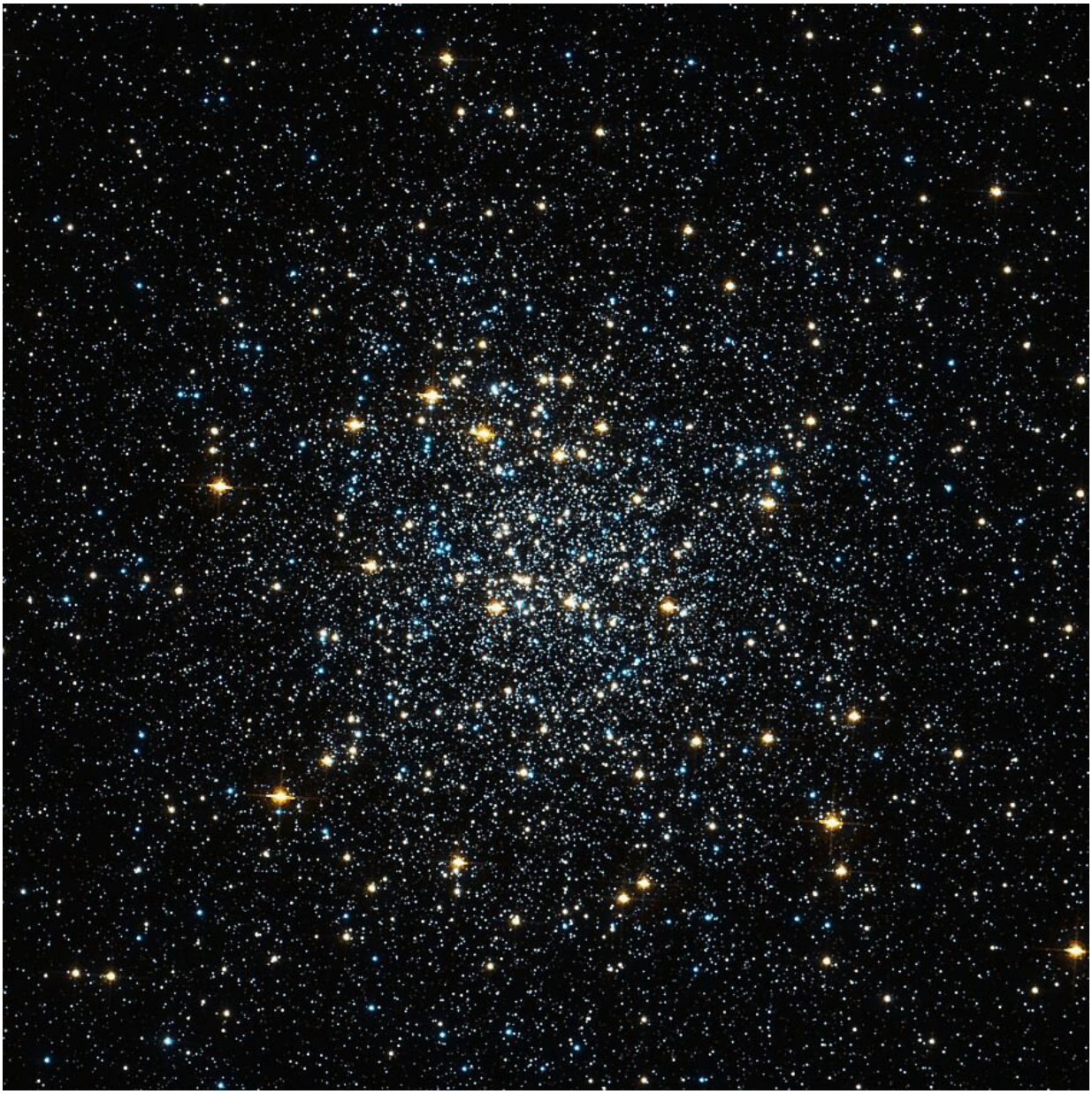
Astronomers explore multiple stellar populations in Messier 92

April 24 2023, by Tomasz Nowakowski



Hubble Space Telescope image of Messier 92. Credit: NASA/STScI/WikiSky.

Using the James Webb Space Telescope (JWST) and the Hubble Space Telescope (HST), astronomers from the University of Padua, Italy, and elsewhere have observed a metal-poor globular cluster known as Messier 92. The observations deliver crucial information regarding multiple stellar populations in this cluster. Results were published April 12 on the *arXiv* pre-print server.

Studies show that almost all globular clusters (GCs) exhibit star-to-star abundance variations of light elements such as helium (He), oxygen (O), nitrogen (N), carbon (C) and calcium (Na). This indicates self-enrichment in GCs and suggests that star clusters are composed of at least two stellar populations.

Located some 26,700 light years away in the constellation of Hercules, Messier 92 (or M92 for short) is a GC with a metallicity of just -2.31 and a mass of about 200,000 solar masses. The cluster, estimated to be 11.5 billion years old, is known to host at least two stellar generations of stars—named 1G and 2G. Previous studies have found that Messier 92 has an extended 1G sequence, which hosts about 30.4% of cluster stars, and two distinct groups of 2G stars (2GA and 2GB).

A team of astronomers led by University of Padua's Tuila Ziliotto decided to inspect these stellar populations of Messier 92, taking advantage of data collected by JWST and HST.

"This paper investigates multiple populations in metal-poor GCs by combining HST and JWST photometry of M 92, a metal-poor GC with [Fe/H]=−2.3, with isochrones and synthetic spectra," the researchers wrote.

The observations identified the three previously reported stellar groups, namely 1G, 2GA and 2GB. These three stellar populations were found to share similar radial distributions of the proper motion dispersion, which range from about 0.2 mas/year near the cluster center to 0.15 mas/year around a distance of about 2.2 half-light radii. Moreover, the 1G, 2GA, and 2GB stars turned out to exhibit isotropic motions in the studied radial interval within about 1.5 half-light radii.

Based on the comparison between the observed colors of the cluster stars and the colors derived by synthetic spectra, the astronomers found that helium abundances of 2GA and 2GB stars have higher mass fractions than that of the 1G stars by 0.01 and 0.04, respectively. They noted that helium difference between 2GB and 1G MS stars is consistent with the maximum helium variation inferred for red giant branch (RGB) stars.

Furthermore, color-magnitude diagrams (CMDs) show that main sequence (MS) stars of Messier 92 fainter than the so-called MS knee (a feature in CMD occurring at the low-mass end of the MS) exhibit an intrinsic color spread, which is present among stars with masses of about 0.1–0.4 solar masses. These low-mass stars appear to exhibit a continuous color distribution and do not showcase evidence for distinct groups of 1G and 2G stars.

More information: Tuila Ziliotto et al, Multiple Stellar Populations in Metal-Poor Globular Clusters with JWST: a NIRCam view of M 92, *arXiv* (2023). DOI: 10.48550/arxiv.2304.06026