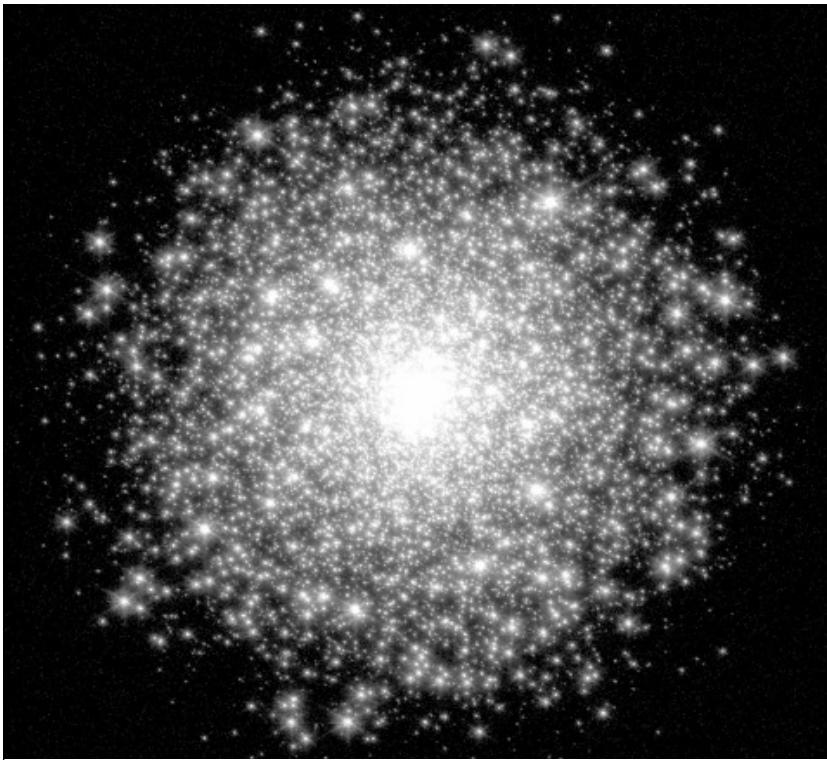# James Webb Space Telescope:
## Age Dating of Clusters



A simulated JWST/NIRCam image of a star cluster observed at 0.9 microns

Age dating of globular star clusters has revealed them to be among the oldest objects known in the Milky Way. As such, precision ages for these objects represent an important constraint on when baryonic structure formation began in the Universe. JWST's Near Infrared Camera (NIRCam) and Near Infrared Imager and Slitless Spectrograph (NIRISS) will enable unprecedented observations of this population at much higher sensitivity and resolution than currently available. For a dozen star clusters, JWST will map the complete white dwarf cooling sequences of each system using a combination of red-optical and near-infrared imaging (e.g., F090W and F150W filters on NIRCam). The luminosity function of these white dwarfs offers a precise age diagnostic for each cluster, one that is independent of the uncertainties in main-sequence turnoff methods.
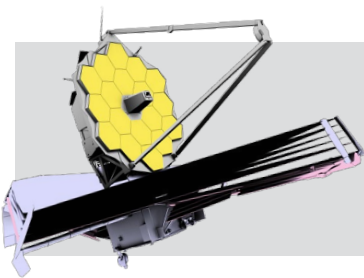
**How Blue Can JWST Go?** Although JWST is an infrared-optimized observatory, the NIRCam instrument offers broadband imaging at 0.7 and 0.9 $\mu$m. The superb sensitivity and resolution will enable a wide range of stellar astrophysics studies at red-optical and near-IR wavelengths.
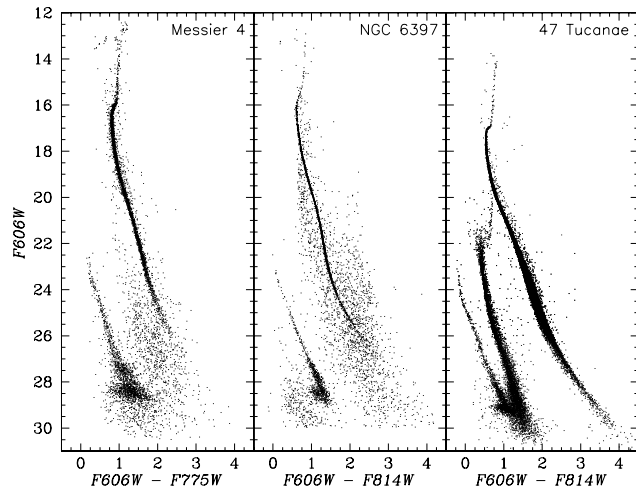
## JWST's Near Infrared Camera (NIRCam)

- ▶ Dual channel imager covering $0.6 - 5\ \mu$m
- ▶ 2.2' x 4.4' field of view
- ▶ Nyquist sampled imaging at 2 micron (0.0317''/pixel)
- ▶ 26 filters (narrow, medium, and wide band)
- ▶ S/N = 10 at K = 27.5 AB mag in 10 min
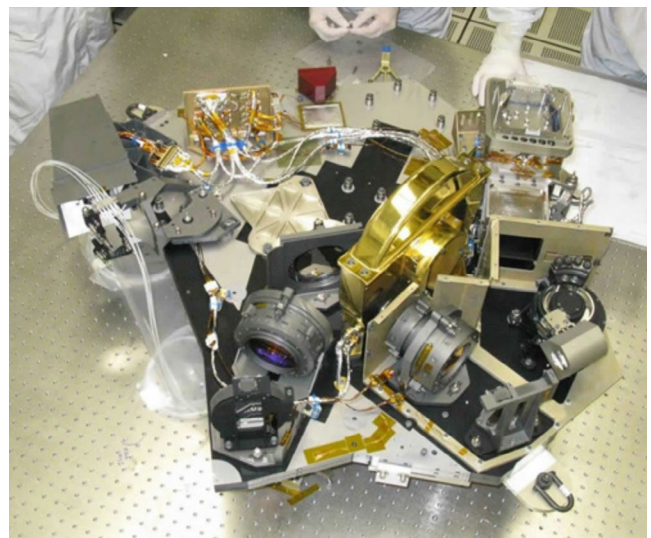
# Precision White Dwarf Cooling Ages for a Dozen Globular Clusters



## An HST Legacy – Precision Ages of Star Clusters

Ultra-deep HST/optical imaging of the three nearest globular clusters has resolved their complete white dwarf cooling sequences (faint blue populations). Modeling the color-magnitude diagrams provides accurate and (main sequence) independent ages for these fundamental calibrators.

Richer, H., et al. (2004, AJ, 127, 2771)
Hansen, B., et al. (2007, ApJ, 671, 380)
Kalirai, J., et al. (2012, AJ, 143, 11)
Hansen, B., et al. (2012, in prep)

NIRCam imaging of globular clusters and other dense astrophysical environments will take advantage of the instrument's multiplexing capabilities. NIRCam is a dual channel imager covering 0.6 - 5 $\mu$m, with a large 2.2' x 4.4' field of view. The two channels provide simultaneous imaging at short (<2.5 $\mu$m; 0.0317''/pixel) and long (>2.5 $\mu$m; 0.0648''/pixel) wavelengths. These capabilities will enable the first characterization of the complete stellar populations in a dozen clusters, extending from the coolest main-sequence dwarfs, through the turnoff and post main-sequence phases, down to the faintest remnant white dwarfs. The color-magnitude diagrams of these systems represent a fundamental calibration for many astrophysical relations. They are the best test of stellar evolutionary processes and form a critical input for population synthesis studies that are aimed at interpreting light from the Universe. JWST's high-precision imaging will enable the most sensitive characterization of the color-magnitude diagram and its dependencies on age and metallicity.

| Cluster | $(m-M)_0$ | $A_{F814W}$ | Target WD (F814W) | F090W (hours) | F150W (hours) |
|---|---|---|---|---|---|
| NGC 6121 | 11.7 | 0.54 | 27.4 | 1.0 | 1.5 |
| NGC 6397 | 11.8 | 0.27 | 27.4 | 1.0 | 1.5 |
| NGC 104 | 13.2 | 0.06 | 28.5 | 6.9 | 10.6 |
| NGC 6656 | 12.5 | 0.53 | 28.2 | 4.0 | 6.1 |
| NGC 6752 | 13.0 | 0.06 | 28.3 | 4.9 | 7.4 |
| NGC 6838 | 13.0 | 0.37 | 28.6 | 8.3 | 12.6 |
| NGC 6254 | 13.2 | 0.41 | 28.8 | 12.5 | 18.3 |
| NGC 6218 | 13.5 | 0.28 | 29.0 | 17.2 | 26.4 |
| NGC 3201 | 13.5 | 0.34 | 29.0 | 17.2 | 26.4 |
| NGC 5139 | 13.6 | 0.18 | 29.0 | 17.2 | 26.4 |
| NGC 6809 | 13.6 | 0.12 | 28.9 | 14.4 | 21.9 |

See more at **jwst.stsci.edu** and **jwst.nasa.gov**
and do your own ETC calculations at **jwst.etc.stsci.edu**

Images courtesy of NASA