Multiple Populations in Globular Clusters

A manual re-analysis of APOGEE spectra

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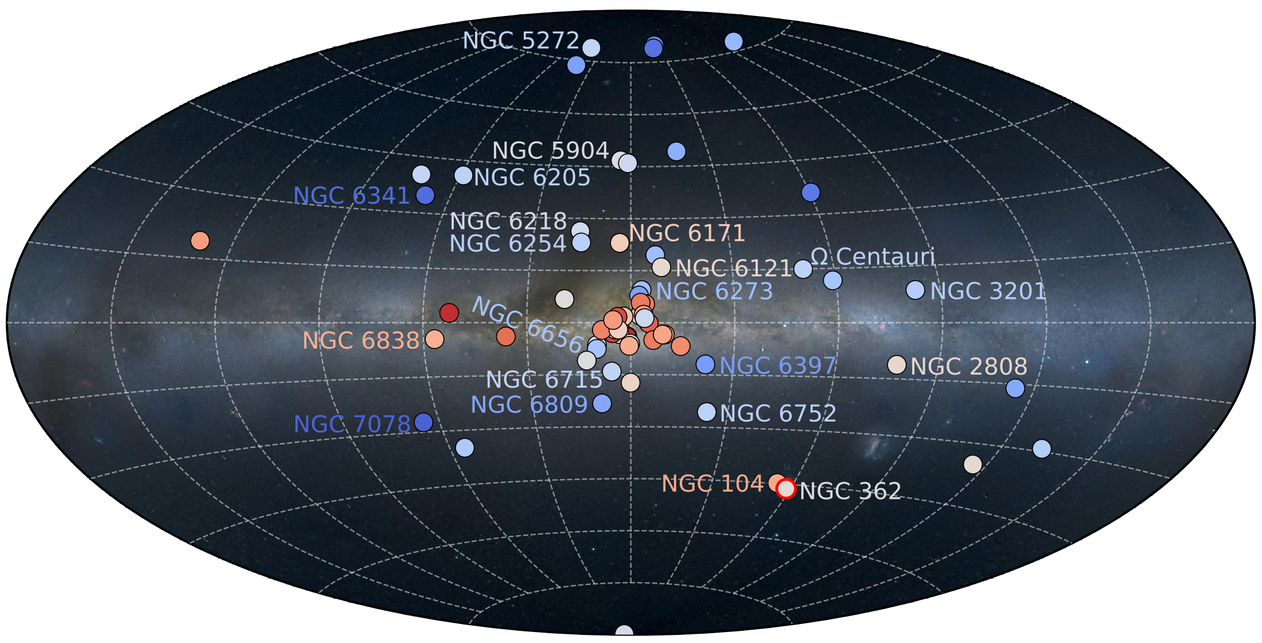
Background

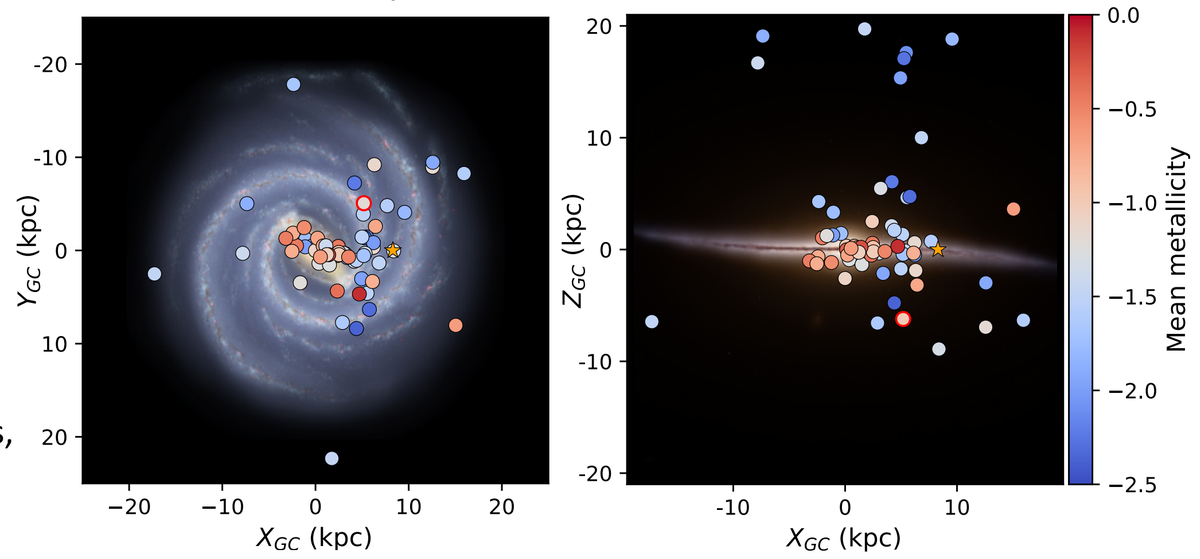
Globular clusters each contain at least two populations: **Population 1 (similar chemistry to field stars)** and **Population 2 (chemically peculiar)** with a large range of abundances of light elements (O, Na, Mg, …). All our spectra have been analyzed with the APOGEE ASPCAP pipeline, but its treatment of α-elements makes it ineffectual at analyzing chemically peculiar stars. In our approach, we treat all abundances individually and manually confirm the spectral fits. Our aim is to provide a large, homogenously analyzed set of abundances with a higher accuracy and precision than automatic pipelines can provide.



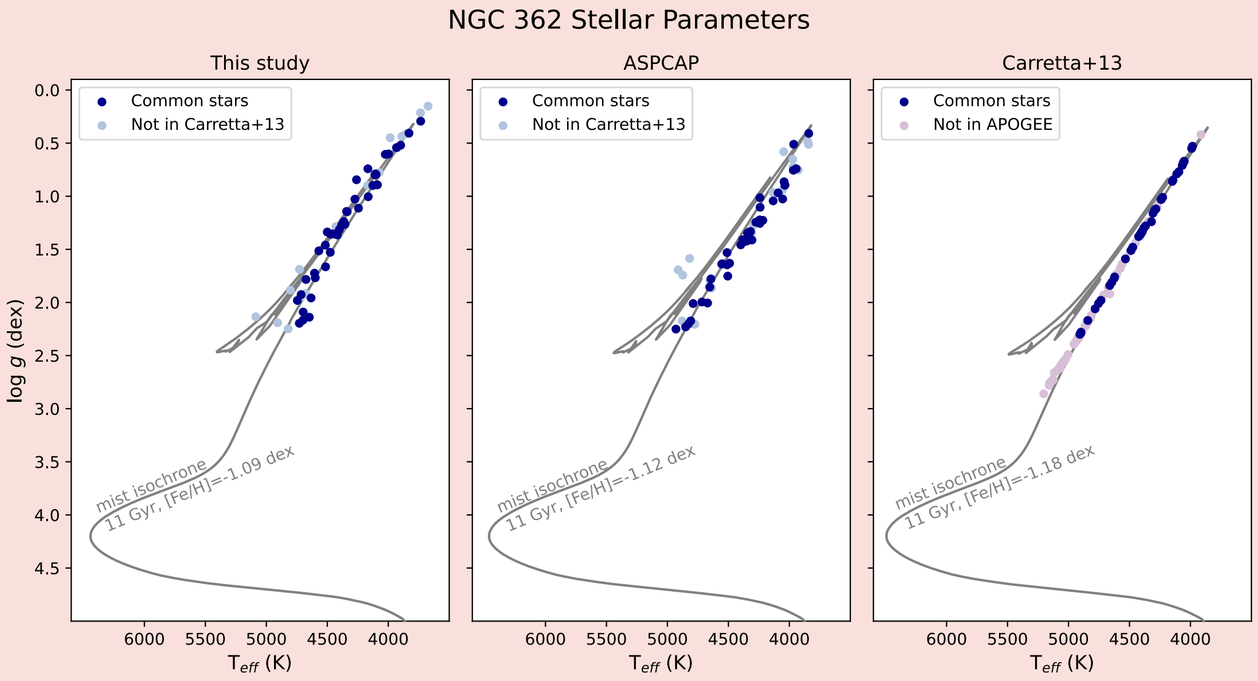
Sky plot: Clusters with more than 50 members in our sample are labelled. **Face-on and Edge-on:** The Sun is marked with an orange star. Cluster coordinates, distances, and mean metallicities taken from Harris 1996 (2010 edition).

Sample

- **6017 spectra** from APOGEE DR 17 (Abdurro'uf et al., 2022)
- **5325 unique stars** in **70** galactic globular clusters
- Typically **10-70 stars per cluster**; 1800 stars in Ω Centauri
- NGC 362, which we use as an illustrative example below, has 59 members in our sample



Preliminary Stellar Parameters



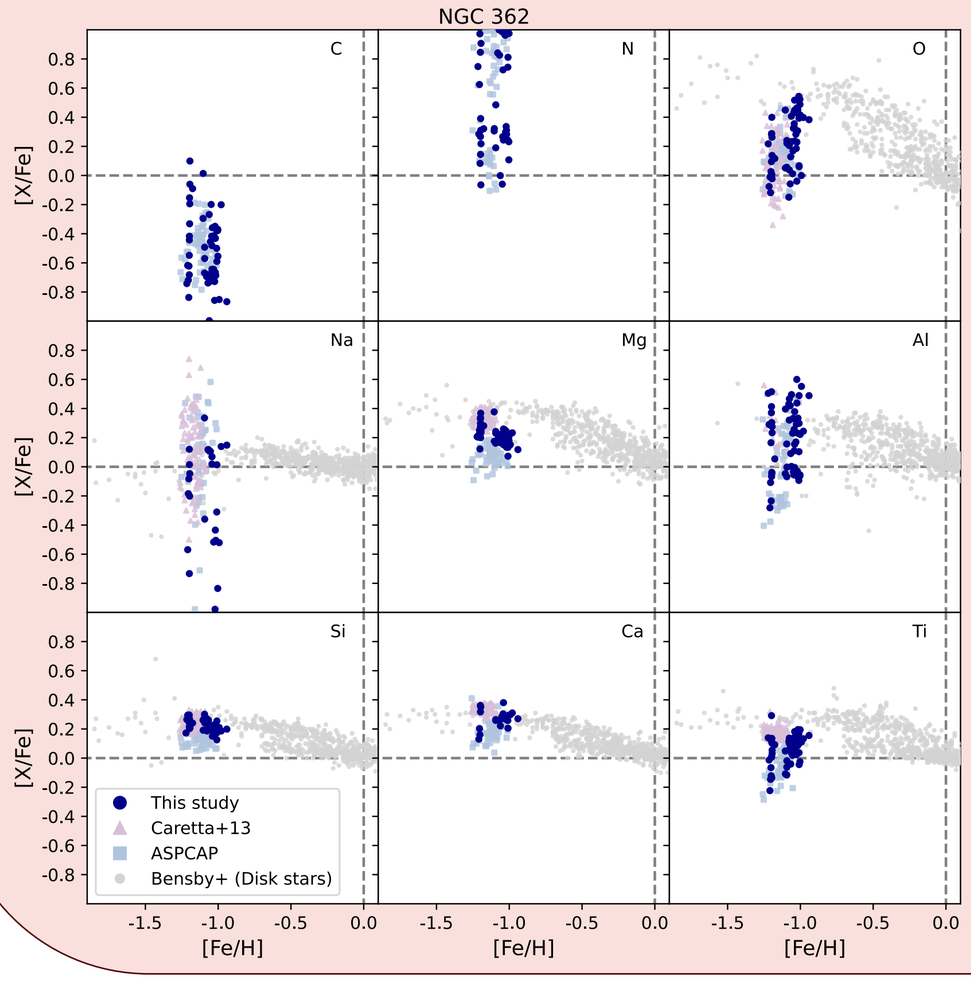
- T_{eff}, [Fe/H], and broadening: Determined spectroscopically
- log *g*: Determined from the fundamental relation:

From isochrones → $\frac{M}{M_\odot}$; From photometry → $\frac{L}{L_\odot}$

$$\log g = \log g_\odot + \log \frac{M}{M_\odot} - \log \frac{L}{L_\odot} + 4 \log \frac{T_{eff}}{T_{eff\,\odot}}$$

Preliminary Abundances

- Population 2 stars are expected to show a large spread in light elements (here: C, N, O, Na, Al)
- The characteristics of this spread and which elements display it varies between clusters, possibly due to cluster mass or metallicity. See e.g. Milone & Marino (2022) for a review.
- We aim to measure these and more elements for all 70 clusters



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Key references:

Abdurro'uf, Accetta, K., Aerts, C., et al. 2022, ApJS, 259, 35

Carretta, E., Bragaglia, A., Gratton, R. G., et al. 2013, A&A, 557, A138

Harris, W.E. 1996, AJ, 112, 1487

Milone, A. P. & Marino, A. F. 2022, Universe, 8, 359

Image credits:

Sky map: Mellinger (2009). Face-on: NASA/JPLCaltech/ESO/R. Hurt. Edge-on: ESA/Gaia/DPAC, Stefan Payne-Wardenaar.