Multiple Populations and Globular Cluster Mass

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Enrichment in Globular Clusters

Globular clusters are dense star clusters found in star-forming galaxies

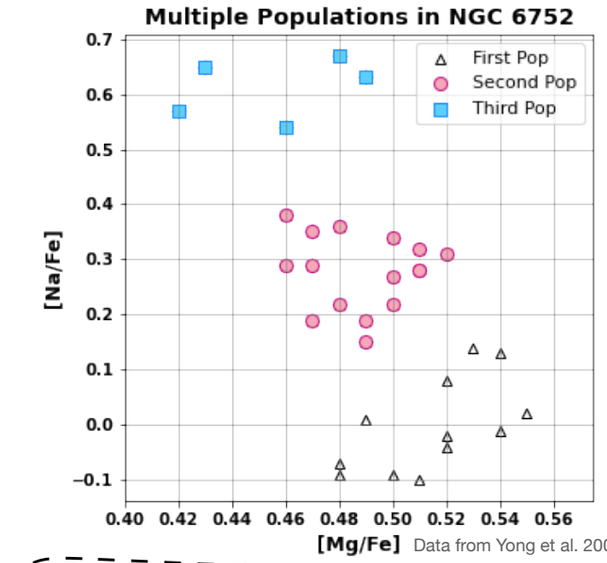
Some stars in these clusters have a unique chemical pattern not found in other stellar systems.

Groups of these stars are *enriched* in elements like Na and Al, and *depleted* in elements like Mg and O.

The phenomenon of these enrichment groups is called *multiple populations.*

Despite these patterns being observed more than 50 years ago (see Osborn 1971), we *still* don't know why the correlations form.

We observe and analyze stars in the disrupted globular cluster stream *300S* to probe chemical enrichment in low-mass clusters.



The above plot shows an example of the correlated chemical pattern seen in globular clusters called *multiple populations*. Note that "first pop" refers to unenriched stars, not to Pop I stars.

Mass Loss & Tidal Stripping

The mass we measure in globular clusters *today* is not the same as the mass that they formed with.

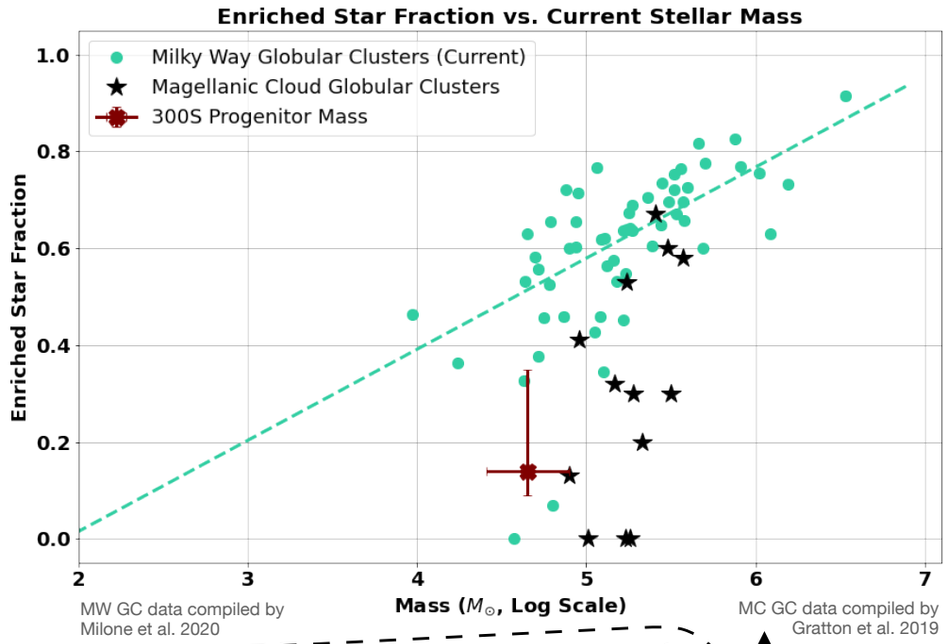
As they move along their orbits around their host galaxies, globular clusters lose mass due to tidal forces.

If multiple populations happened at the time of formation, we would expect a closer correlation between the fraction of enriched stars and initial mass, as shown on the right:

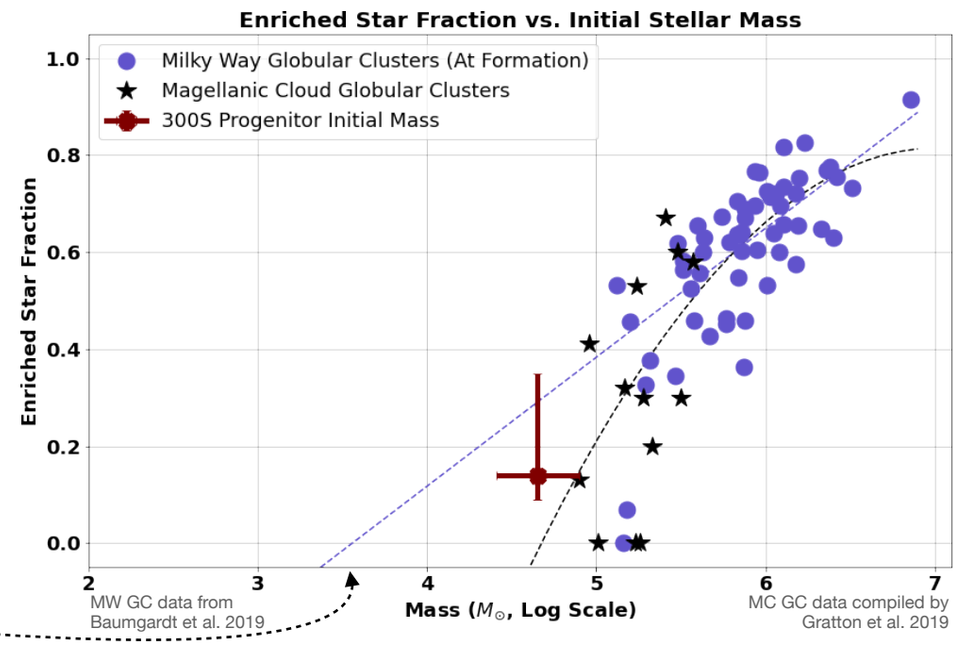
Correlation with Mass

We have one clue about the formation of multiple populations: there is a correlation between the *mass of a globular cluster* and the *fraction of enriched stars* found therein.

There may even be a critical mass *threshold* that needs to be reached for stars to form multiple populations.



The correlation between the mass of a cluster and the fraction of enriched stars becomes more clear when we calculate the initial mass of the globular clusters.



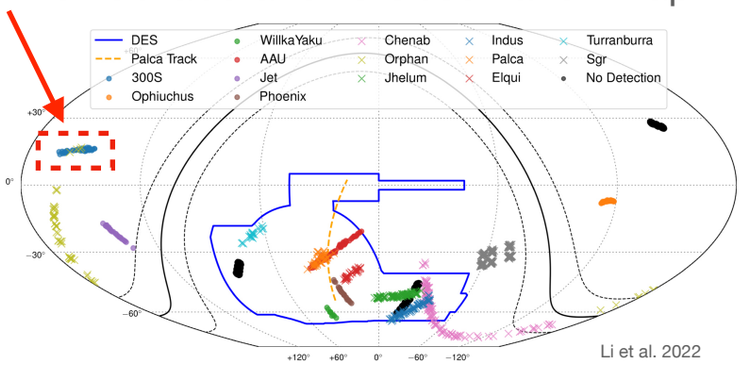
What is a stellar stream?

A tidally disrupted stellar system orbiting the Milky Way in a line; progenitors are thought to be globular clusters or dwarf galaxies

Stellar streams are used to:

- Reconstruct Milky Way merger history
- Constrain dark matter halos
- *Test low-mass regime of globular clusters for multiple populations*

S⁵ Collaboration's Observation Map



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Results

We observed 8 red giant branch member stars in a disrupted globular cluster, the 300S stellar stream. We found just one to be enriched.
This *doesn't* match with the correlation seen in current mass, but agrees with the correlation in initial mass.

Conclusions

- Multiple populations are not well understood
- We can look for a critical threshold for chemical enrichment by observing stellar streams and other low-mass systems
  - Our observation of 300S aligns with the correlation with initial mass

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