Multiple Populations in Globular Clusters: Stellar Dynamics and Collisions

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Multiple Populations in Globular Clusters

About half the stars in GCs are formed from material that has gone through hot hydrogen burning → helium enhancement and light element anti-correlations

Formation mechanism = ?????
Leading contenders include AGB stars, (super)massive stars, binaries...

See Giampaolo’s talk on Thursday evening for the full picture

Bastian & Lardo 2017
Open questions

• What is the source of enriched material?

• Why aren’t stars with these abundance patterns seen elsewhere in galaxy?

• How can stars form in dense stellar environments?
• Mass budget problem, stochasticity problem, discreteness problem........
Dynamics Questions

• What does spatial distribution of populations tell us about formation mechanisms?

• What effect does high helium abundance have on stellar dynamics?
NBODY6MP – different helium abundances

- MS lifetime as function of Y from Chantereau+ 2015 – implemented in NBODY6MP
- Centrally concentrated high helium population (Y=0.32) – turnoff mass difference of 0.15 M☉
- More rapid spatial mixing (slight)
- Tidal environment has a much larger effect than helium

Miholics, Webb & Sills 2015

Fare, Webb & Sills 2018
Collisions happen

• Between stars
  
  • Runaway collisions in densest clusters
  
  • Encounters harden binary stars

\[ Y = \begin{cases} 
0.30 & \text{He} \\
0.64 & \text{ex} 
\end{cases} \]

\[ Y_{ex} = 0.64 \]

\[ Y_{av} = 0.30 \]

Ejected Mass (M_\odot)

\[ \text{de Mink} + 2009 \]

\[ \text{Gieles} + 2018 \]
Collisions happen

- Between clusters

Howard, Pudritz, Harris 2016

Sills, Rieder, Scora, McCloskey, Jaffa 2018
A natural result of massive cluster formation?

Howard, Pudritz, Harris, Sills 2018
Conclusions

• Multiple populations still confuse us
• A lot can happen in 10 Gyr
• Stellar helium abundance has an effect on stellar dynamics
  • But not as important in strong tidal environment
• Cluster formation is complex
  • And that complexity may hold the solution to the multiple population problem