Observational Properties of Blue Straggler Stars in GCs

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A peculiar stellar population: brighter and bluer (hotter) than the TO

- More massive than “normal” population
- Their existence can’t be interpreted in terms of evolution of a single star
Blue Straggler Stars (BSS)

Two possible formation mechanisms:

- **COLLISIONS**

- **MASS-TRANSFER**
Blue Straggler Stars (BSS)

BSS more massive than normal stars:

Gravitational probe-particles to test internal dynamical processes
The dynamical friction (DF) timescale depends on:

- star mass
- local cluster density

\[ t_{DF}(r) \propto \frac{1}{M_{BSS} \rho(r)} \]

BSS radial distribution to probe GC internal dynamics
Blue Straggler Stars (BSS)

What we need:

Complete samples of BSS, especially in the central regions
BSS observations in GC

The “classical” optical diagram

Cool giants (RGB/AGB) are much brighter than BSS

But:

BSS are hotter, i.e. brighter at shorter wavelengths
BSS observations in GC

Key points:
- UV sensitivity
- High resolution allow to resolve hot stellar populations in the cores of high density GC
BSS observations in GC

Data reduction strategy:

• Construction of a **master-list** of stars using the bluest images

• **Force a fit** in the other filters using the positions in the master-list
The UV route to search for BSS in GGC

Data from the **HST UV Legacy Survey of GGC** (PI: Piotto):

57 GGC observed in 3 blue filters

See G. Piotto’s talk on thursday afternoon
The UV route to search for BSS in GGC

Data from the HST UV Legacy Survey of GGC (PI: Piotto):

57 GGC observed in 3 blue filters

First results for 4 high central density GGC:
NGC2808, NGC6388, NGC6541, NGC7078 (M15)

Incompleteness of optical-driven catalogs

Bright stars are often affected by incompleteness in available optical surveys of GC, due to saturation effects and/or the inter-chip gap

Stars lost in the optical-driven approach

Stars lost:
- along all evolutionary sequences
- preferentially in the center

Stars lost in the optical-driven approach

NGC6388: \(N_{\text{BSS}}=288\)

61 BSS (~20%) lost in the optical-driven catalog with respect to the UV-driven reduction
BSS radial distribution

Complete samples of BSS, especially in the central regions

What we need:

A dynamical evolution indicator based on BSS radial distribution
Refining the dynamical clock

$10^5$-particles N-body simulations to study the BSS segregation process as a function of time, using the cumulative radial distribution

The area between the BSS cumulative radial distribution and that of a reference population (lighter stars) increases with time.

Definition of $A^+$:

$$A^+(x) = \int_{x_{min}}^{x} \left[ \phi_{BSS}(x') - \phi_{REF}(x') \right] dx'$$

We measured $A^+_{rh}$ (within one half-mass radius from the center)

- is always representative of the cluster global value
- allows a meaningful comparison from cluster to cluster

Refining the dynamical clock

\[ N_{\text{relax}} = \frac{t_{\text{age}}}{t_{\text{rc}}} \]

\( A^+ \) is an efficient tool to rank stellar systems as a function of their dynamical age.

Total: 25 GC
Refining the dynamical clock

\[ N_{\text{relax}} = \frac{t_{\text{age}}}{t_{\text{rc}}} \]

\( A^+ \) is an efficient tool to rank stellar systems as a function of their dynamical age.

\~30\% of the global GC population in the MW

Total: 48 GC

(the HST UV Legacy Survey of GGC, paper XV)
Refining the dynamical clock

\[ N_{\text{relax}} = \frac{t_{\text{age}}}{t_{\text{rc}}} \]

\( \mathbf{A}^+ \) is an efficient tool to rank stellar systems as a function of their dynamical age.

...but what about individual BSS?
BSS spectral energy distributions

- Multi-wavelength BSS photometry; data from ACS/HRC calibration field in the core of 47Tuc (~300 images)

→ Characterise individual BSS properties: physical parameters, companions (degenerate/non degenerate)...
  (similar to e.g. Knigge et al. 2008 for a set of FUV-excess sources)
BSS spectral energy distributions

[SYNTHETIC SPECTRA ONLY SHOWN FOR REFERENCE - NOT A FIT]
• The combination of UV sensitivity and high resolution is essential to study hot stellar populations (such as BSS) in GC.

• The UV-driven search is the most efficient way to obtain complete samples of BSS.

• A+ is an indicator of dynamical evolution; it correlates with the central relaxation time, thus providing an efficient tool to rank stellar systems as a function of their dynamical age.

• Work in progress: study single BSS from their broadband SED; obtain their physical parameters and possibly constrain their formation mechanisms.

Thank you!