OLD STELLAR SYSTEMS IN UV: RESOLVED AND INTEGRATED PROPERTIES

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Cosmic-Lab

- 5-year project
- *Advanced Research Grant* funded by the European Research Council (ERC)
- PI: Francesco R. Ferraro (Dip. of Physics & Astronomy – Bologna University)
- AIM: **to understand the complex interplay between dynamics & stellar evolution**
- HOW: using **globular clusters** as cosmic laboratories and

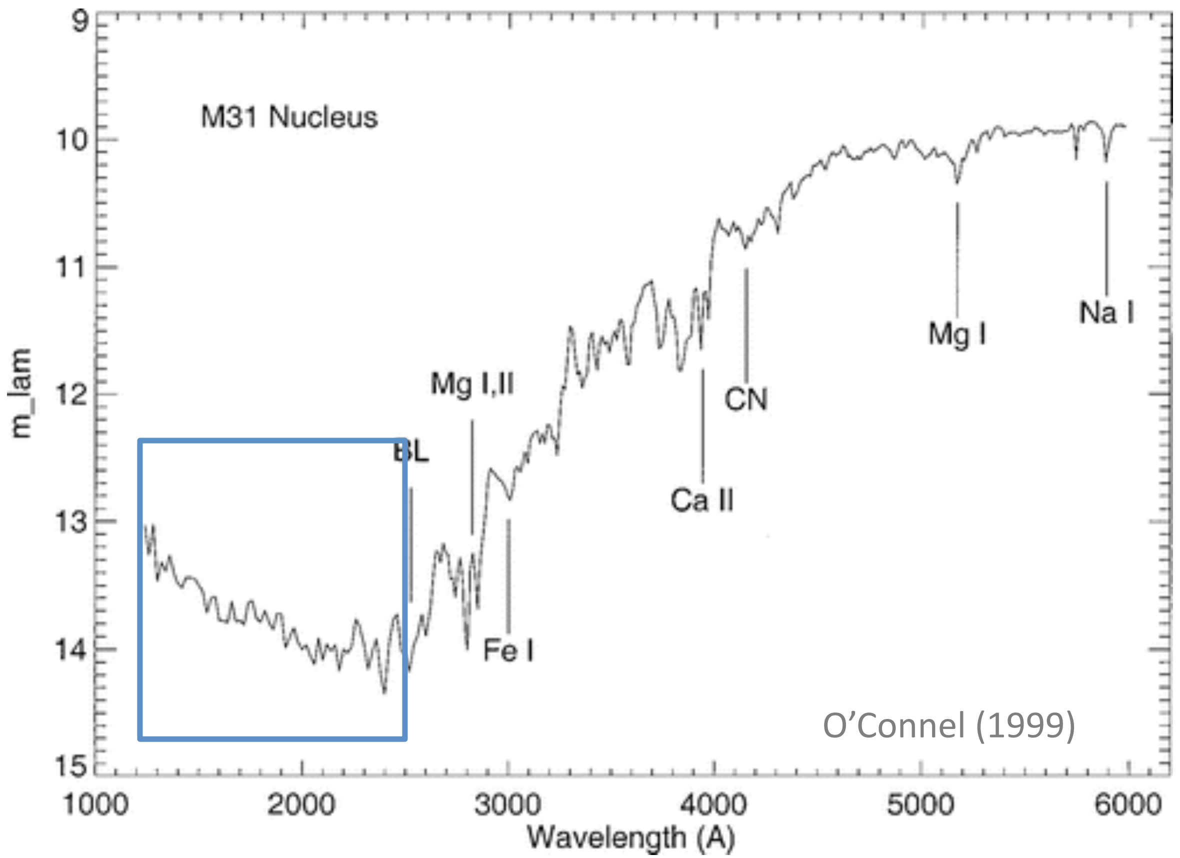
Blue Straggler Stars
Millisecond Pulsars
Intermediate-mass Black Holes

} as probe-particles

Old Stellar Populations in UV

The UV upturn

Understanding the origin and the frequency of hot stars is not simply a problem of understanding the evolution of old, low mass stars. It has important implication on the interpretation spectra of galaxies.



Hot stars have been suggested to be responsible of the UV upturn in the spectrum of elliptical galaxies and bulges
(Greggio & Renzini 1990)

GGCs are the best laboratory

Detailed knowledge of the underlying stellar population → Integrated properties

HST + GALEX: the best tool

HST-WFPC2 UV SURVEY

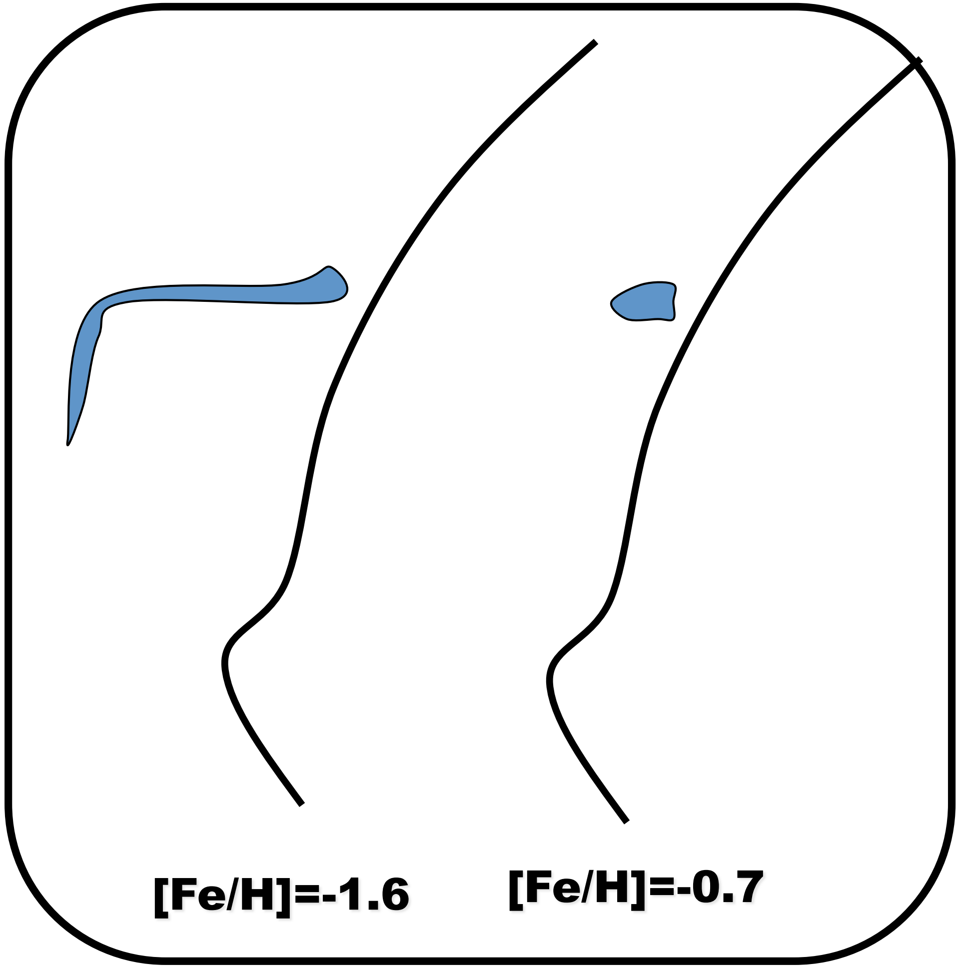
- Prop: GO-11975 – PI: Ferraro
- more than 35 GCs

GALEX SURVEY of GGCs

- PI: Schiavon
- 44 GCs in both FUV and NUV

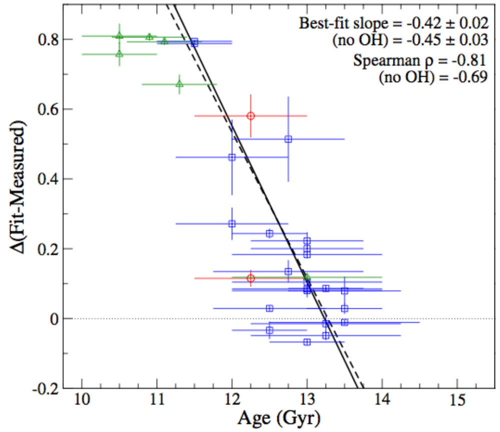
The Horizontal Branch

Metallicity is the first parameter



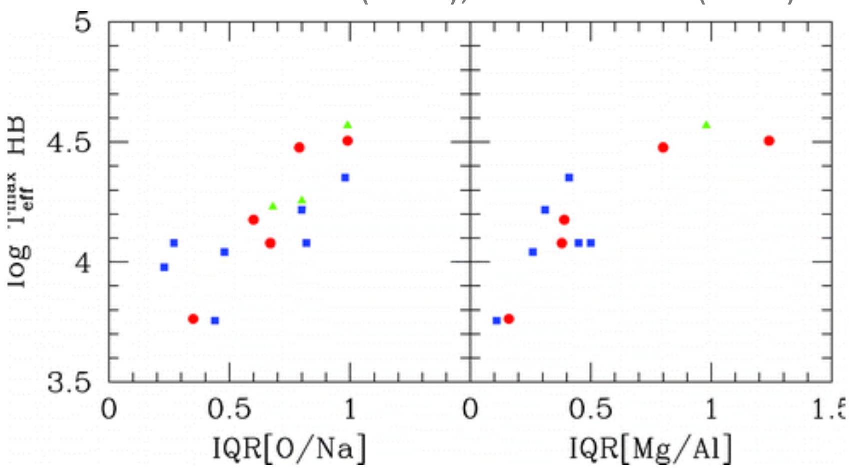
Age is the second

Lee et al. (1194); Dotter et al. (2010);
Gratton et al. (2010)



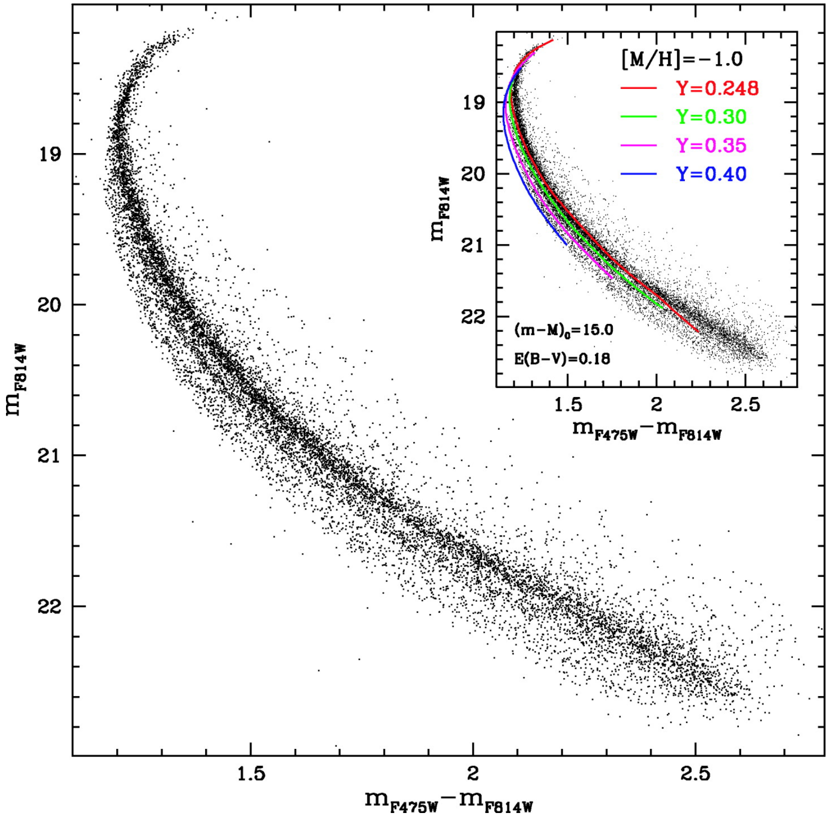
Chemical anomalies also?

Carretta et al. (2007); Gratton et al. (2011)

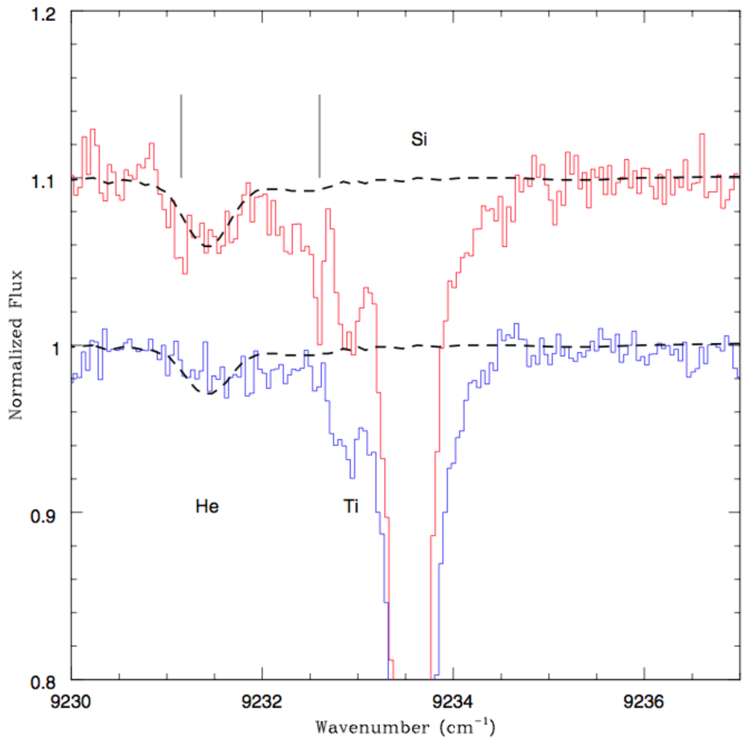


RESOLVED PROPERTIES WITH HST

The Horizontal Branch in UV: NGC 2808

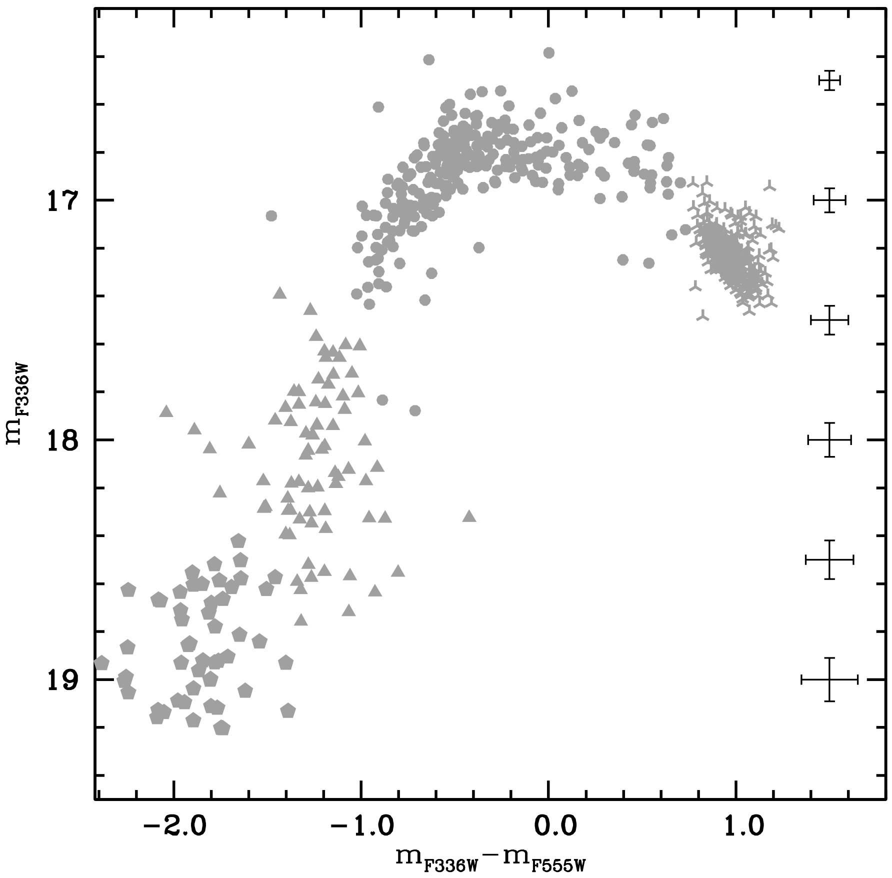


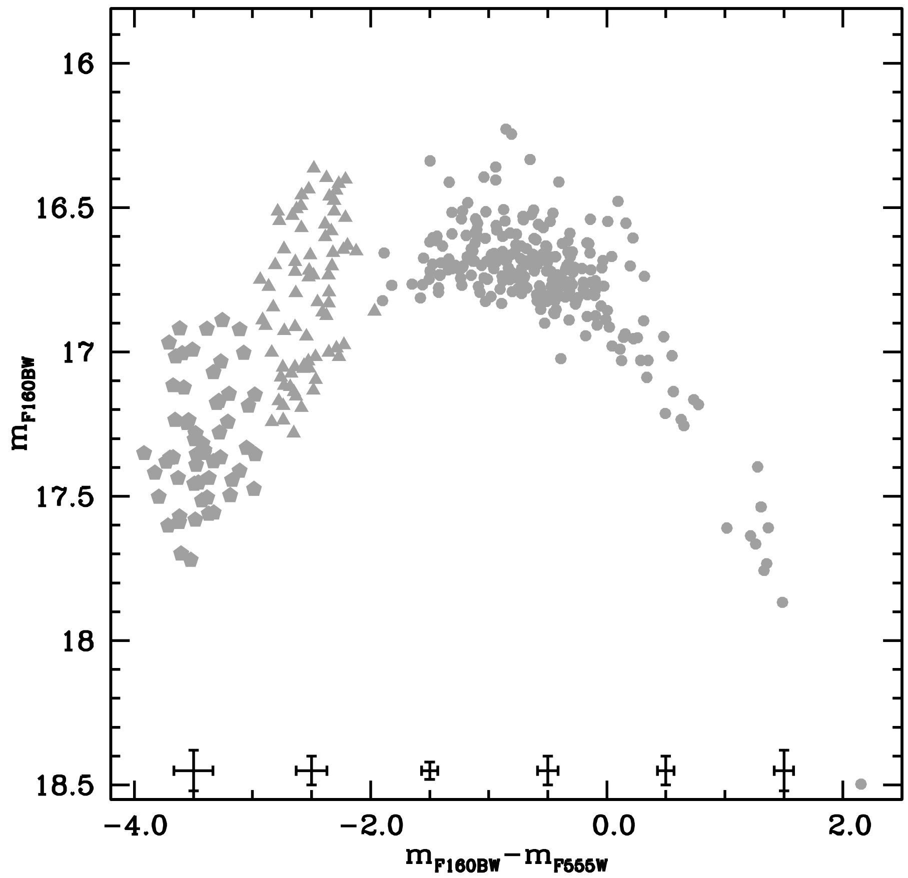
3 sub-populations with different He abundances have been observed from both photometric and spectroscopic analyses (Piotto et al. 2007; Bragaglia et al. 2011; Pasquini et al. 2011)



The Horizontal Branch in UV: NGC 2808

Dalessandro et al. 2011





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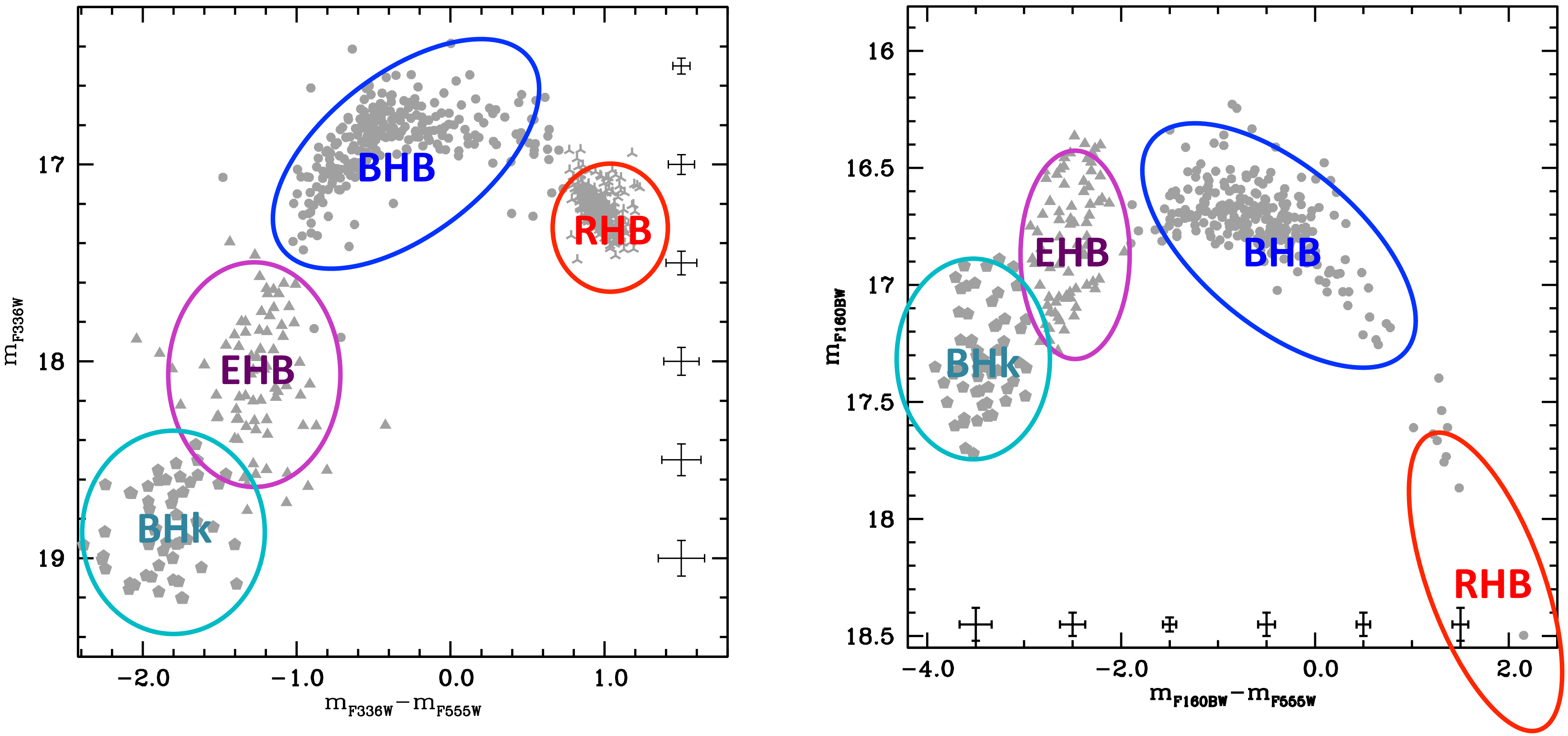

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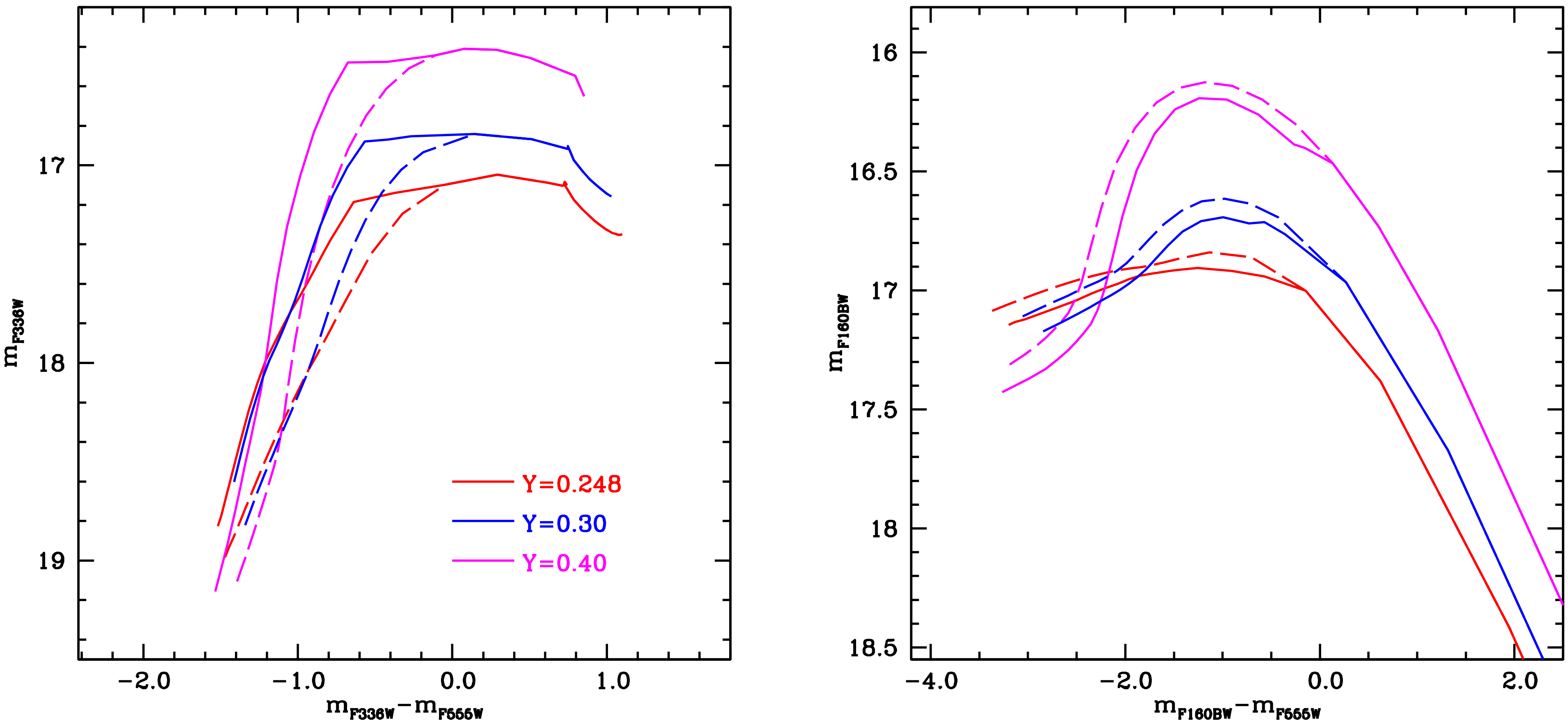
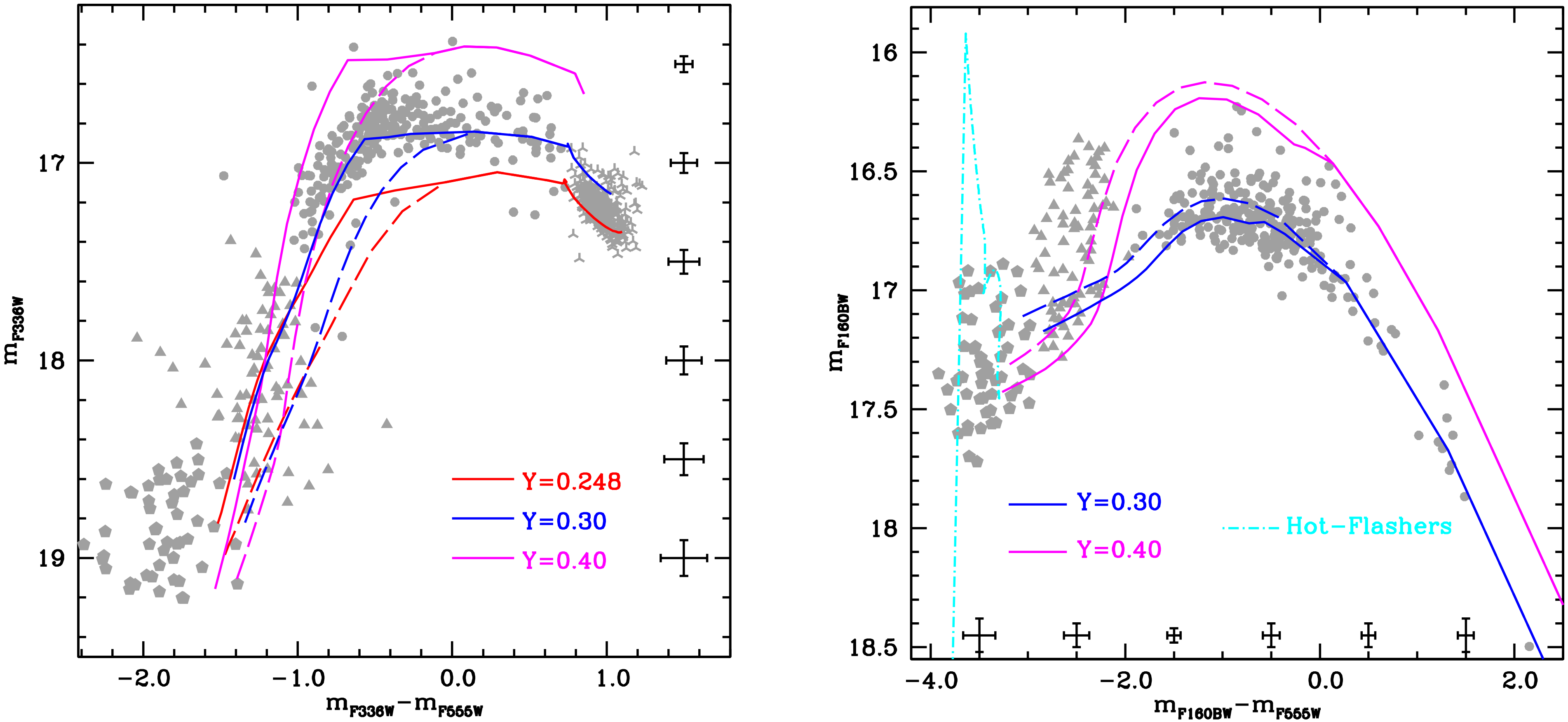


The Horizontal Branch in UV: NGC 2808

Dalessandro et al. 2011

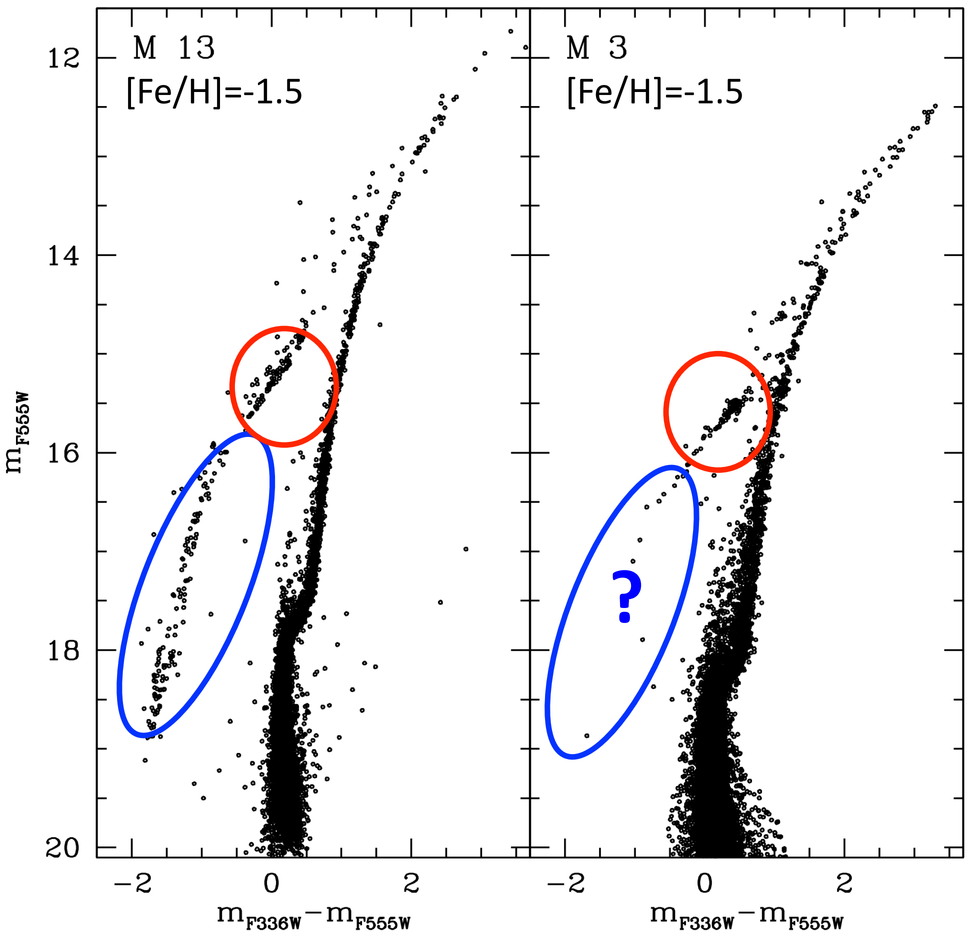


THE HB OF NGC2808 IS FULLY DESCRIBED BY USING 3 POPS WITH DIFFERENT He + HOT-FLASHERS

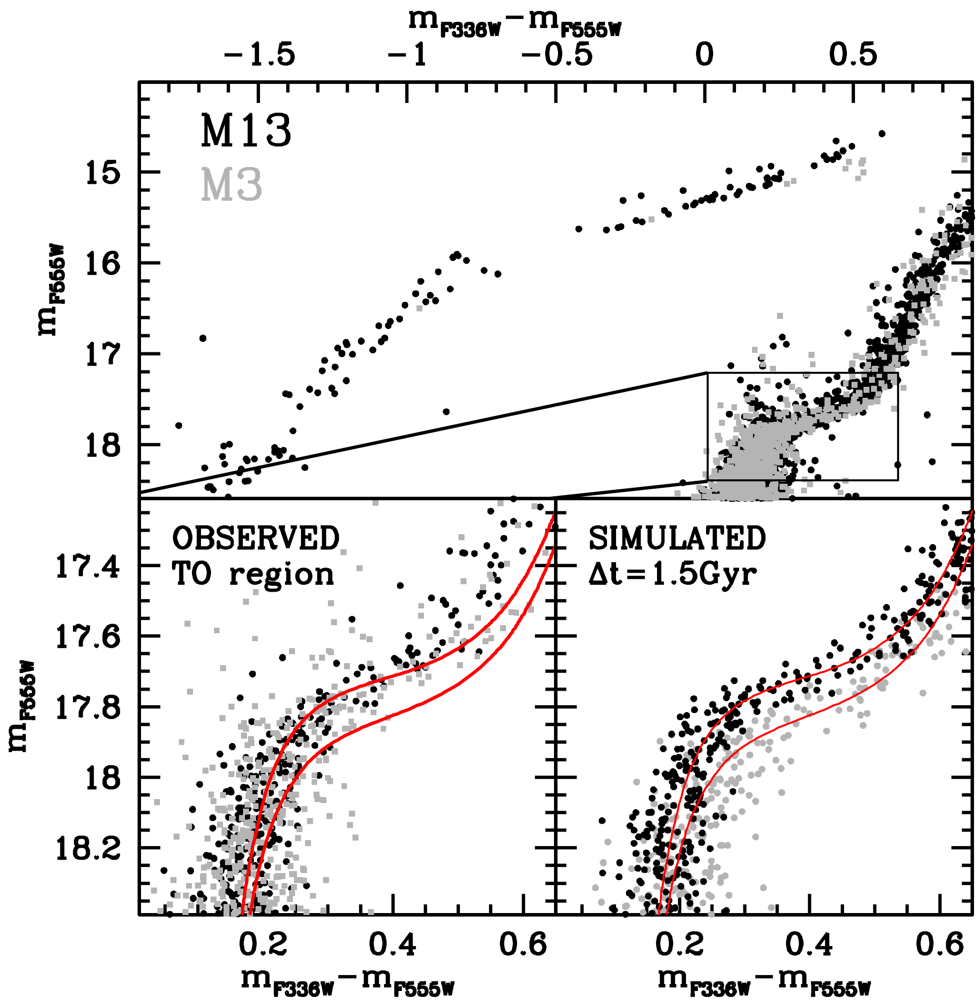
The Horizontal Branch in UV: M 3 – M 13

Dalessandro et al. 2013

DIFFERENT HB MORPHOLOGIES

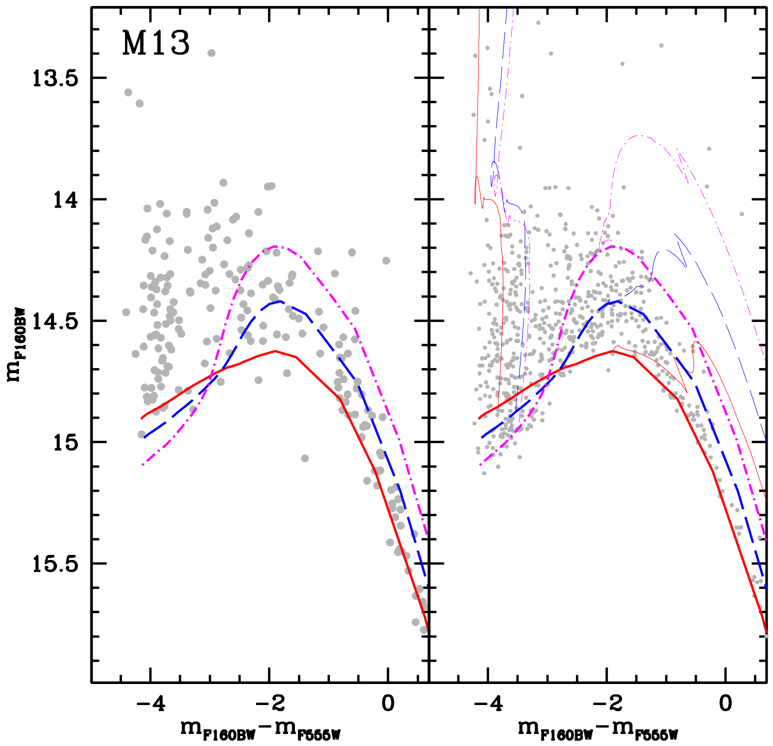


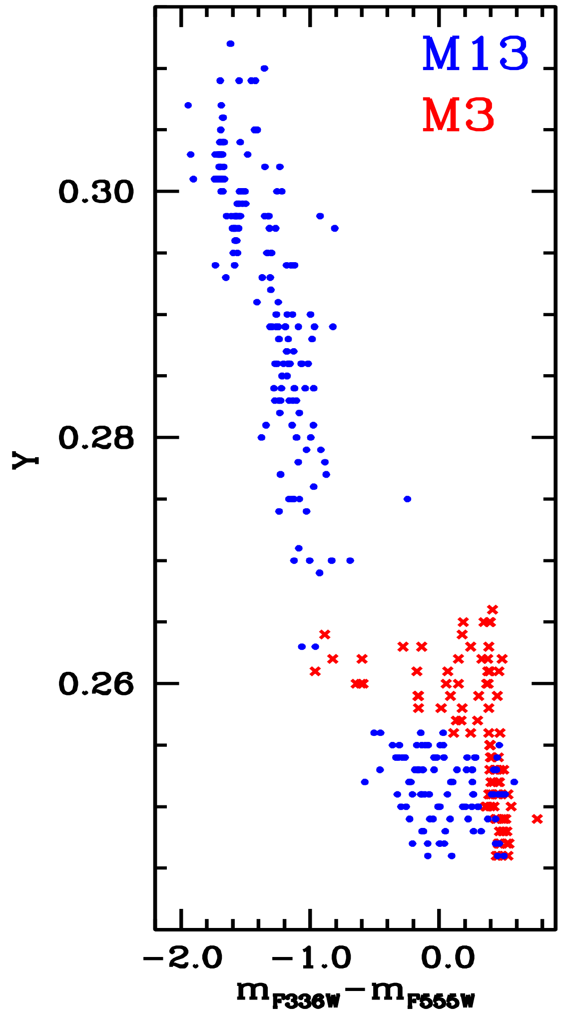
SAME AGE



The Horizontal Branch in UV: M3 – M13

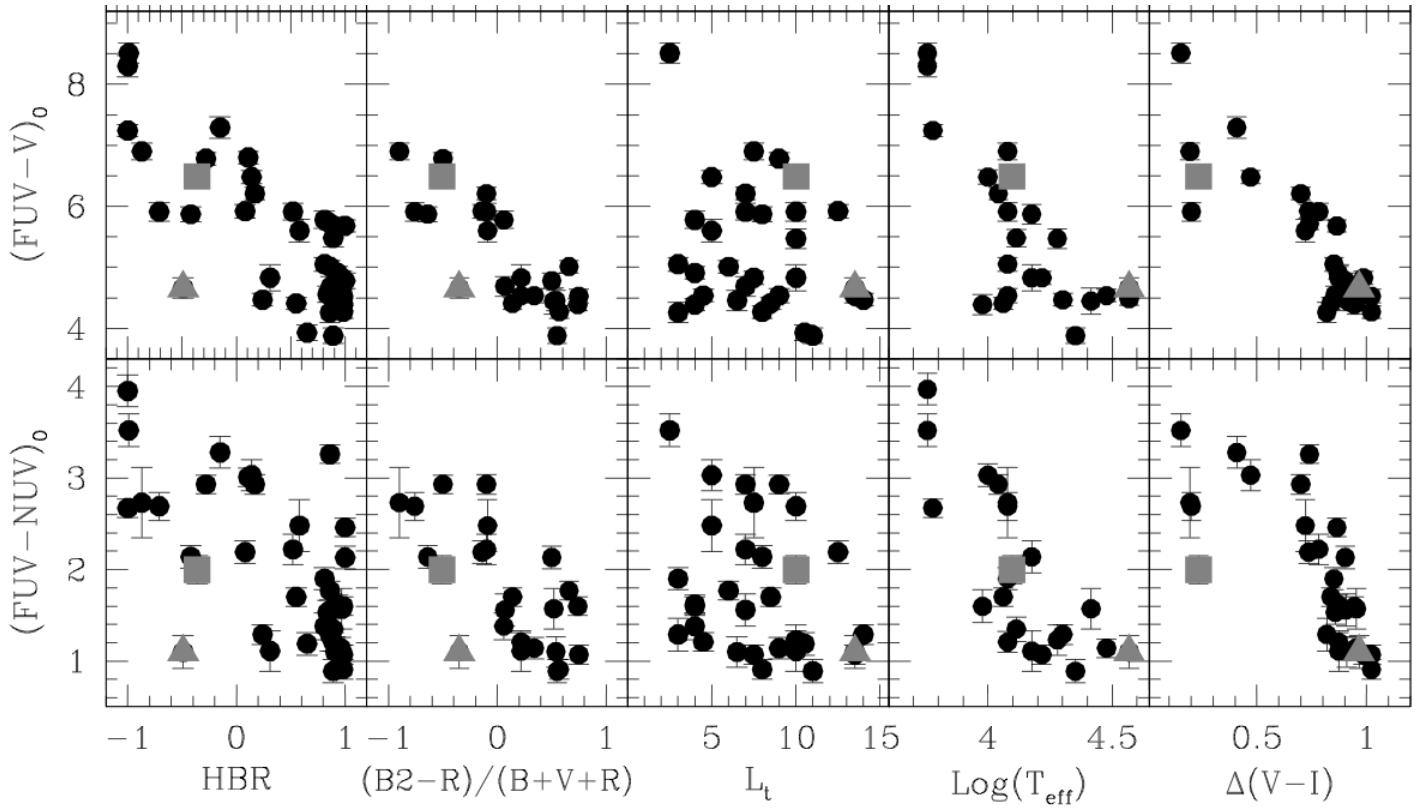
Dalessandro et al. 2013



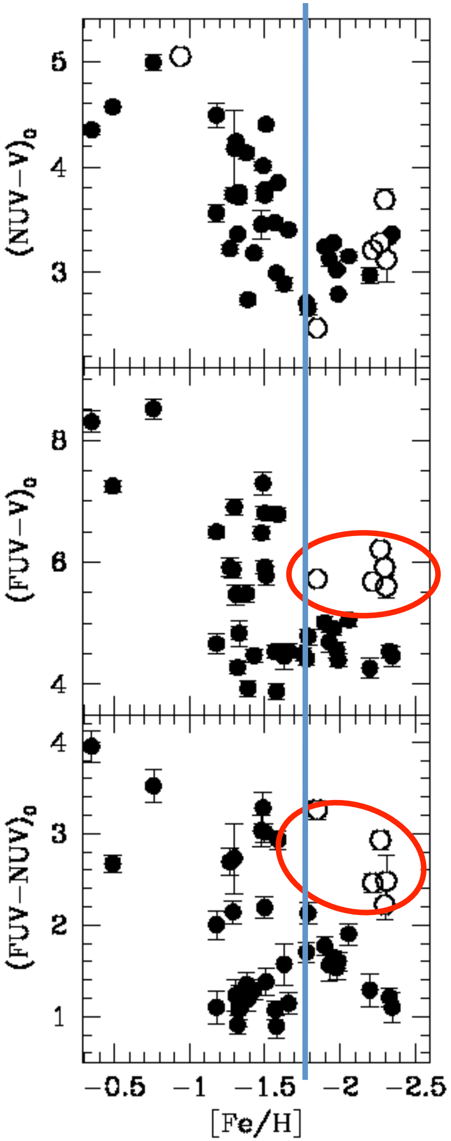


HBs are matched only with different He distributions

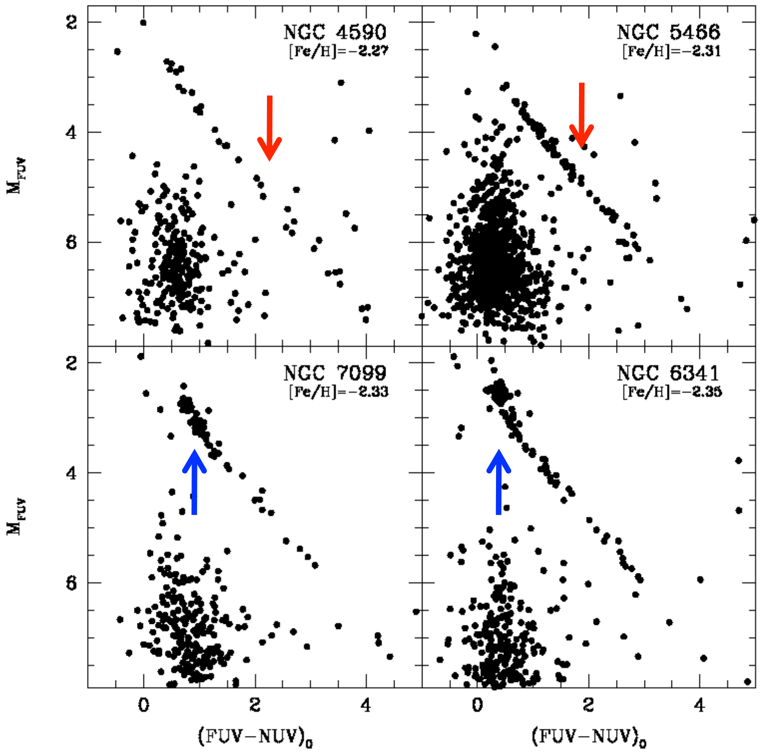
INTEGRATED PROPERTIES WITH GALEX



The Sagittarius clusters



Dalessandro et al. (2012)



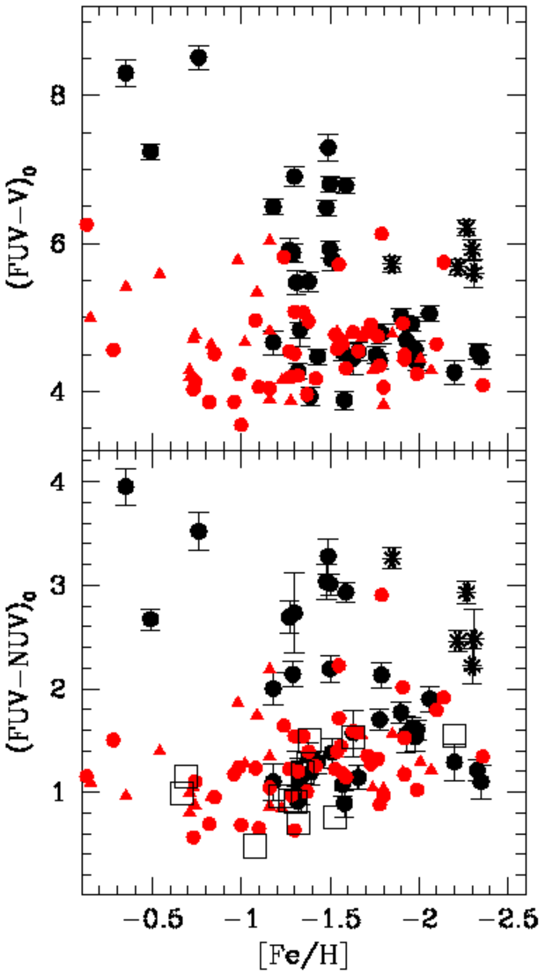
NGC4590, NGC5053, NGC5466, Arp2, Terzan8 and Palomar 12 are suggested to be connected with the Sagittarius Stream

(Dinescu et al 1999, Palma et al. 2002, Bellazzini et al. 2003, Lee & Majewski 2010)

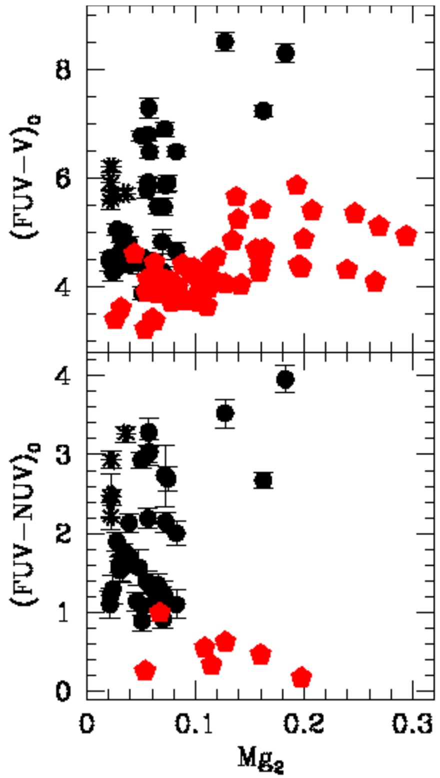
A comparison with the M31 and M87 GCs

Dalessandro et al. (2012)

On average M31 and MW GCs have the same UV colors

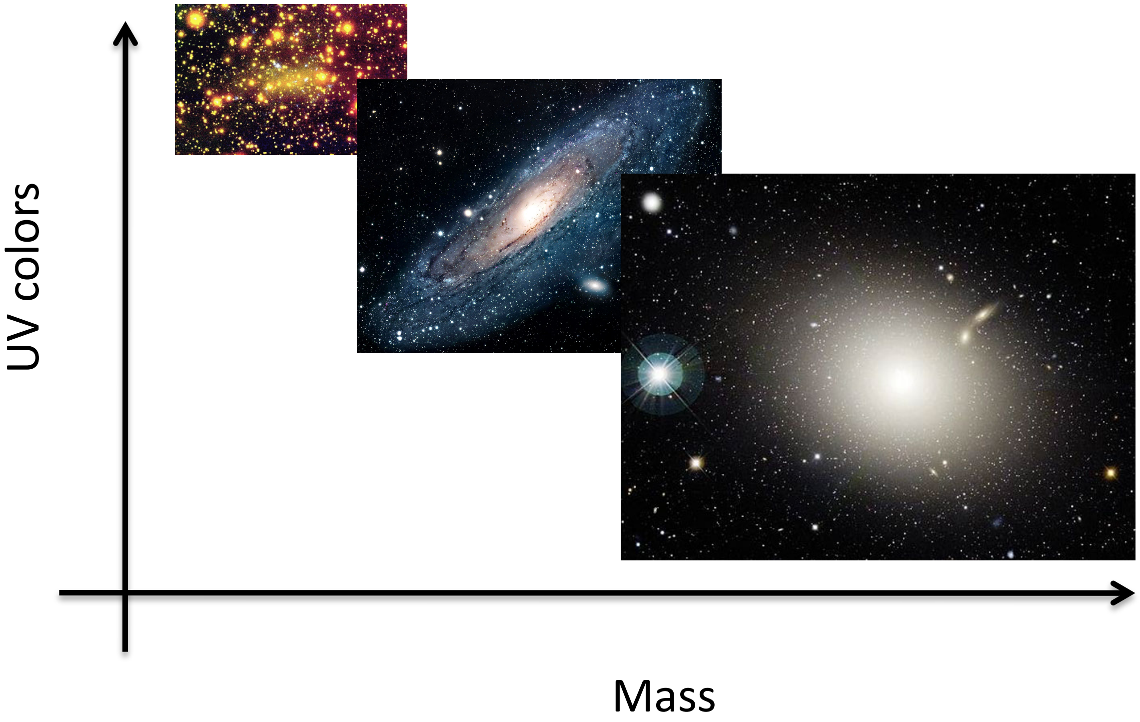


On average M87 GCs are bluer than GGCs



Mass really matters

Dalessandro et al. (2012)



M(Sgr) =1.6×10^8 M_{sun} (Law & Majewski 2010)

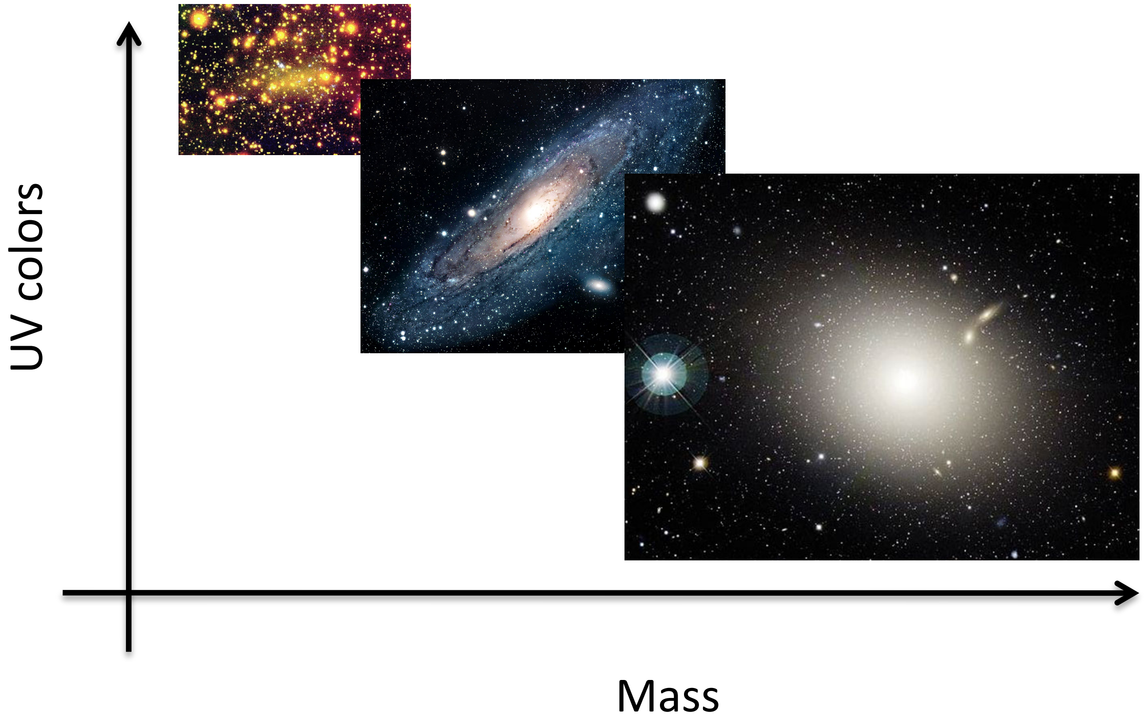
M(MW)= $2.4 \times 10^{11} < M_{sun} < 1.2 \times 10^{12}$ (Little & Tremaine 1987)

M(M31)= $3.7 \times 10^{11} < M_{sun} < 2.5 \times 10^{12}$ (Cote' et al. 2000)

M(M87)=$1.7 \times 10^{13} < M_{sun} < 4 \times 10^{13}$ (Fabricant et al. 1980)

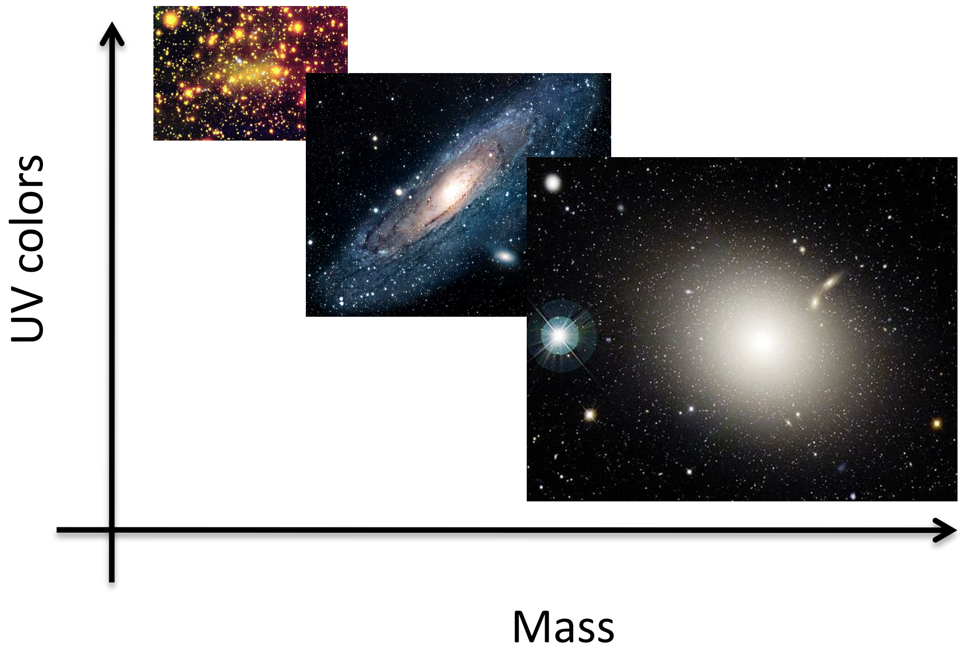
Mass really matters

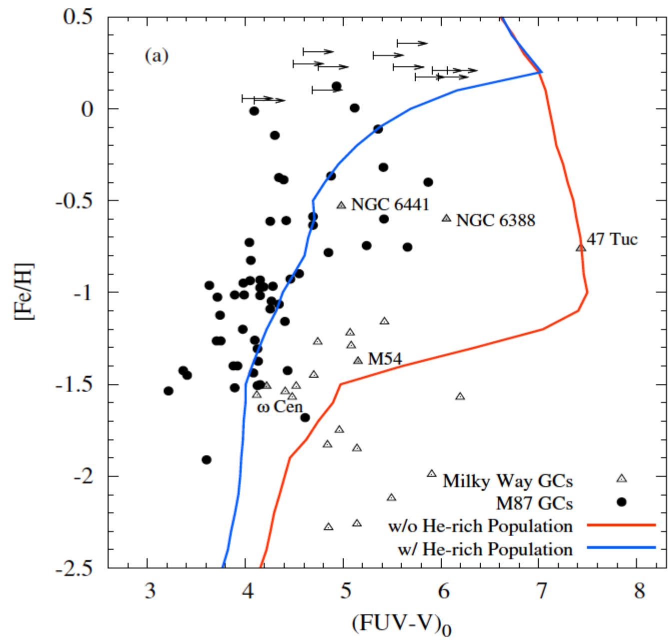
Dalessandro et al. (2012)



UV colors of GC systems get bluer as the mass of the host galaxy gets bigger

Mass really matters





This might be linked to the survival rate of GCs in different environments

GCs in more massive galaxies are likely to undergo more complex history of star formation (Valcarce & Catelan 2011)

Summary

- We combined UV HST and GALEX data for a sample of GGCs with the aim to link resolved to integrated properties

- He content has a strong impact in shaping the HB of old stellar population (see the cases of of NGC 2808 and M 3-M 13)

- We observe a general correlation between UV colors of GCs and mass of the host galaxies

- Differences might be linked to the survival rate of GCs in different environments

Thank you!

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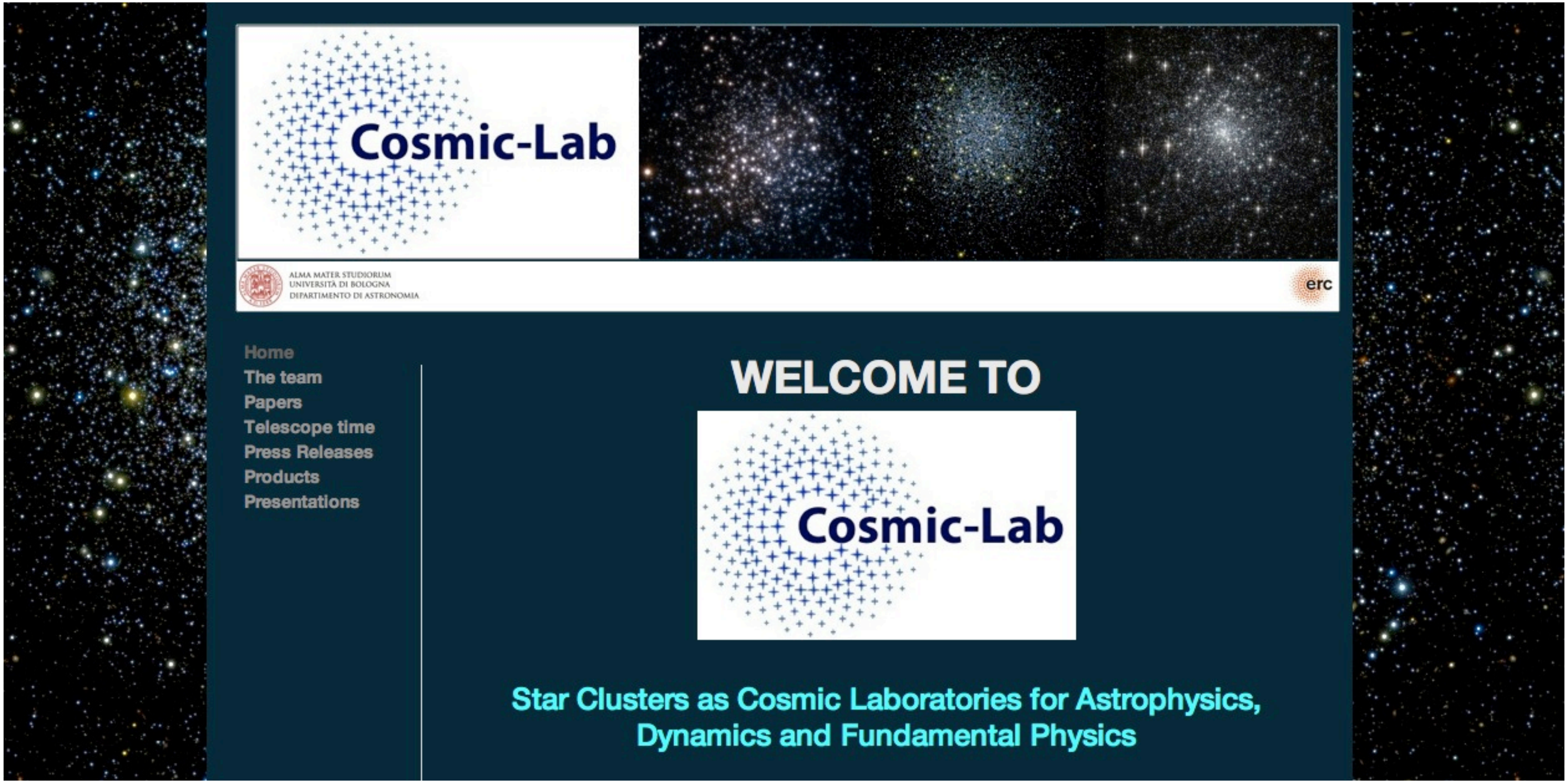

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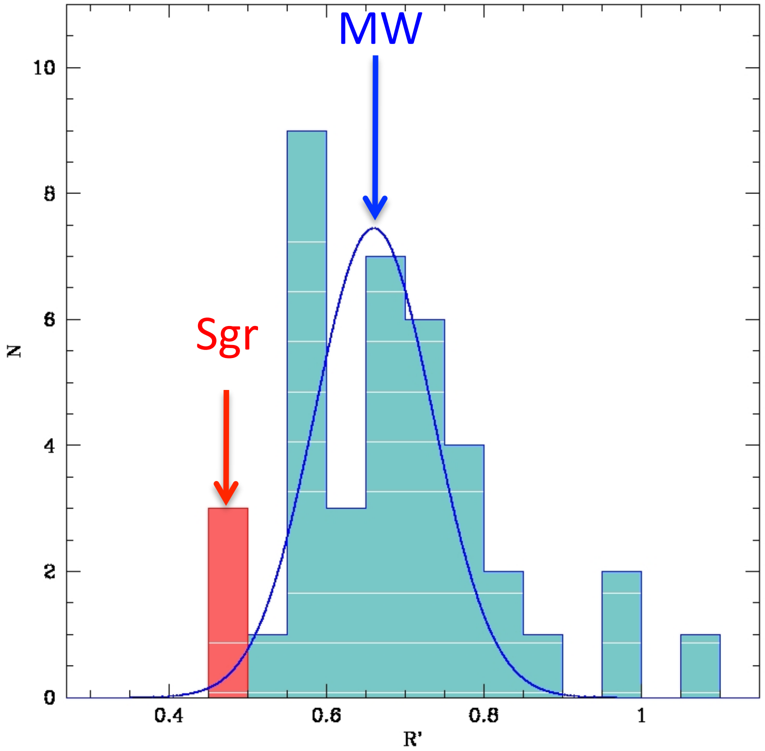

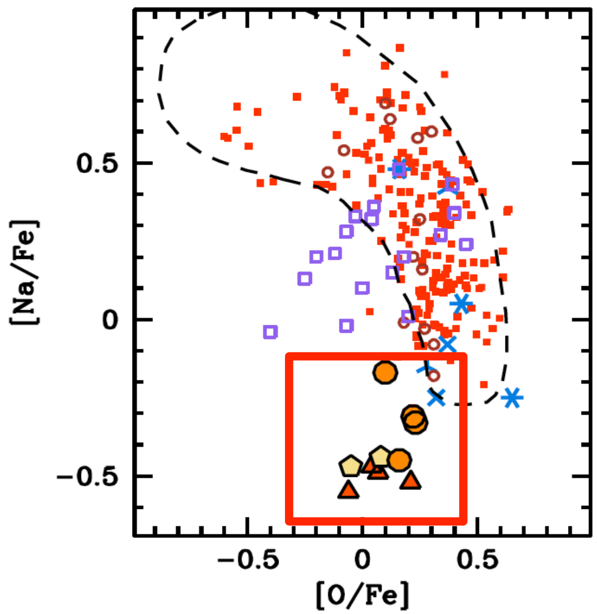

<R'(Sgr)>=0.48±0.01 <R'(MW)>0.74±0.18

A t-test between these mean values gives a P~99.9% that they are different

See also Perina et al. 2012; Fusi Pecci et al. 1993