Chemical properties of Blue Straggler Stars in Globular Clusters

ALESSIO MUCCIARELLI

Physics & Astronomy Department – University of Bologna (Italy)

Cosmic-Lab

www.cosmic-lab.eu

erc

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

The chemical composition of BSS

Searching for chemical signatures
of the BSS formation mechanisms

Collisional BSS

Negligible mixing between inner cores and outer envelopes (Lombardi et al. 1995)

No chemical signatures

Mass Transfer BSS

Mixing with material coming from stellar regions where CNO burning occurs (Sarna & de Greve 1996)

Chemical signatures (**CNO**)

The spectroscopic dataset

High-res spectra with FLAMES@VLT

Searching for signatures of mass transfer: C and O

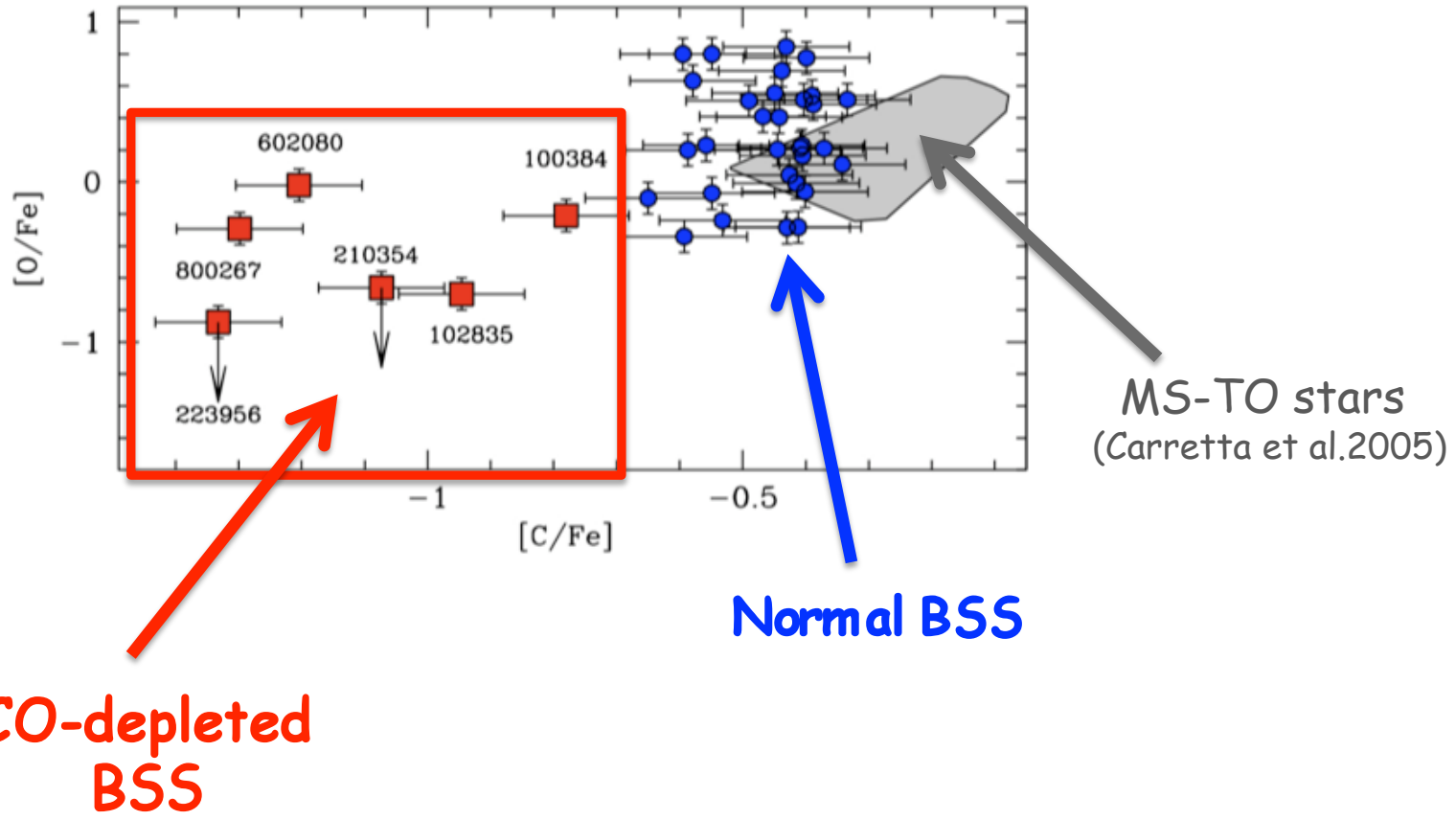
5 GCs

	[Fe/H]		
47 Tuc	-0.7		
M4	-1.1		
NGC 6397	-2.0	PCC	
M30	-2.3	PCC	double BSS sequence
Omega Cen	-1.7		non-collisional BSS

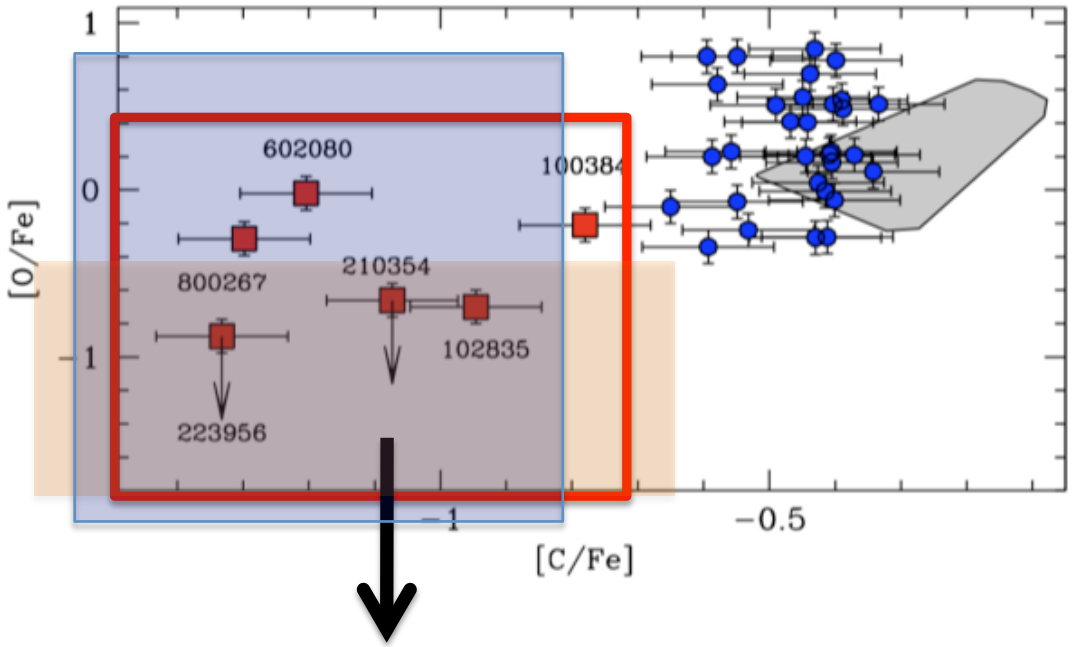
This talk → Chemical analysis of slow-rotating BSS (vsini < 30 km/s)

47 Tuc

Chemical analysis for 43 BSS (Ferraro et al., 2006)



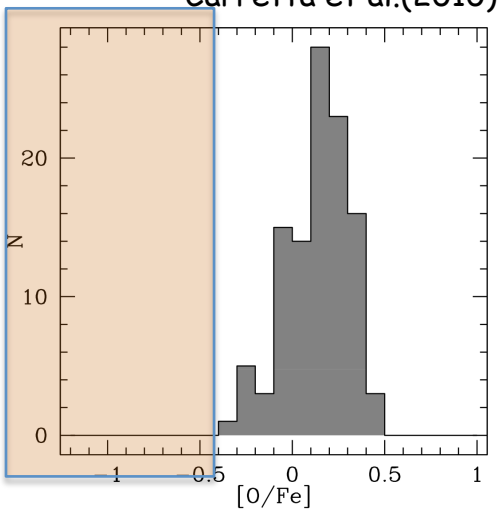
47 Tuc



Can be originated from the second generation stars?

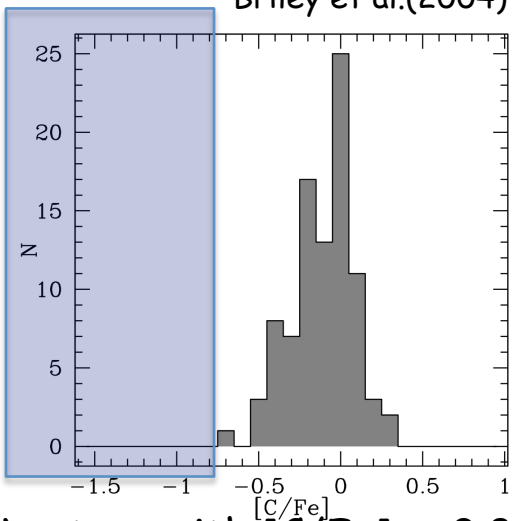
NO !!!

Carretta et al.(2010)



No stars with [O/Fe] < -0.4 dex

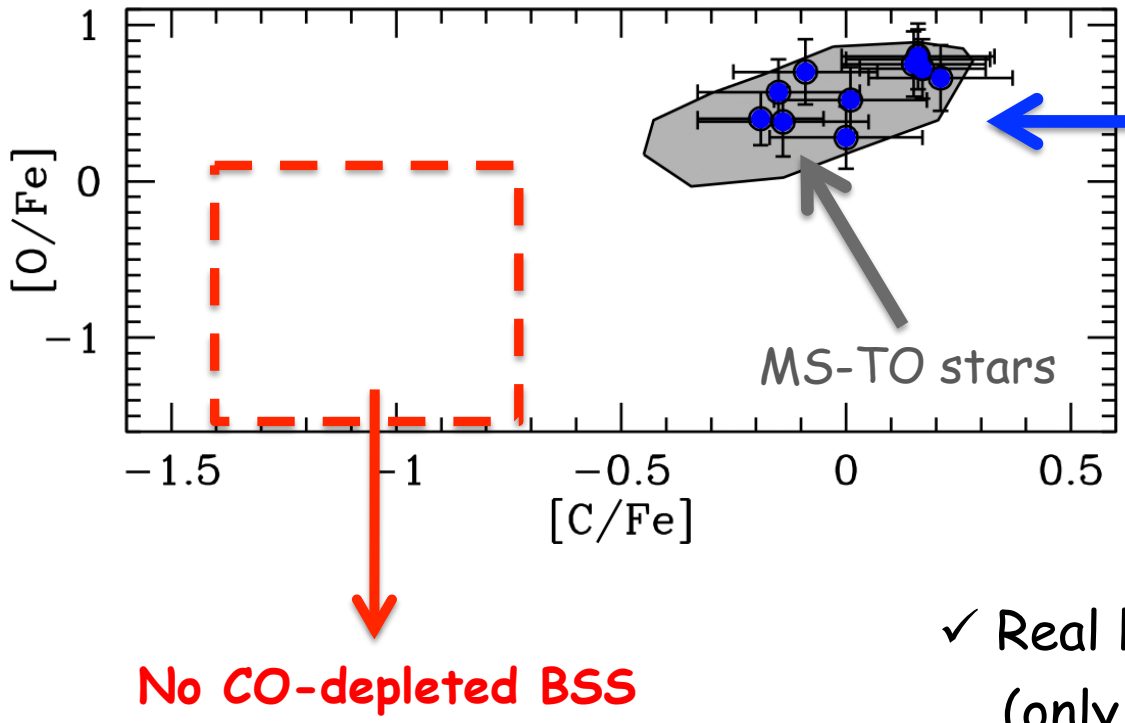
Briley et al.(2004)



No stars with [C/Fe] < -0.8 dex

M4

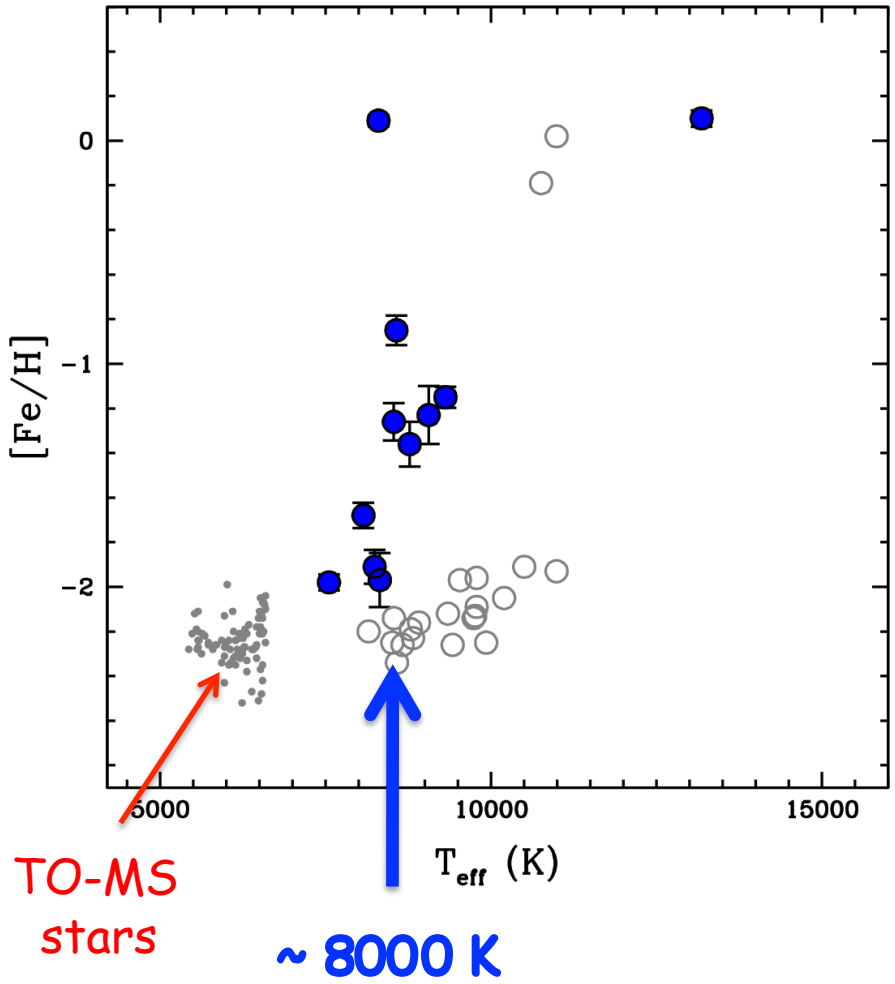
Chemical analysis for 11 BSS (Lovisi et al.,2010)



- ✓ Real lack of MT BSS? (only COL-BSS?)
- ✓ Small statistics problem?

NGC 6397

Chemical analysis for 11 BSS (Lovisi et al.,2012)



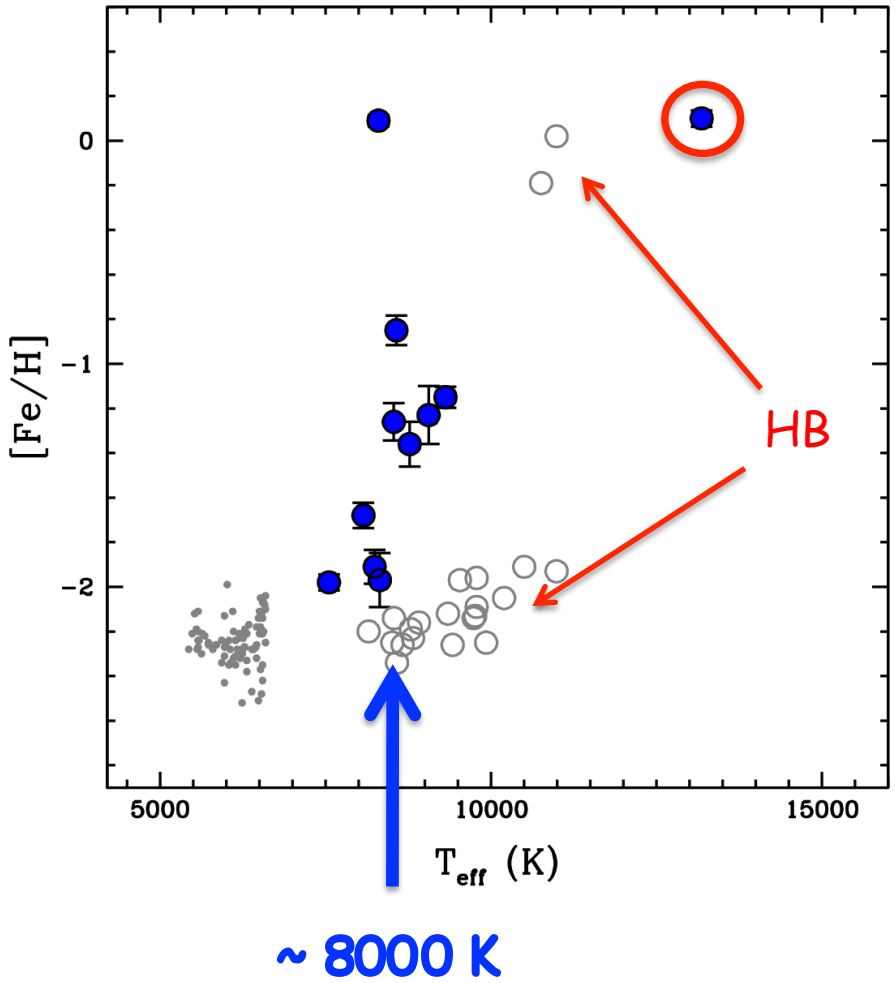
Unexpected large spread in Fe

< [Fe/H] > = -1.2 (σ=0.74)

[Fe/H] increases with Teff

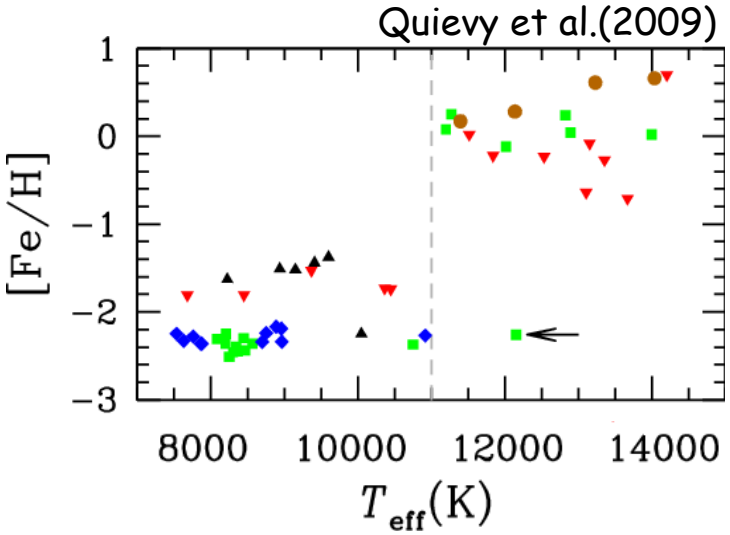
Signature of radiative levitation

NGC 6397

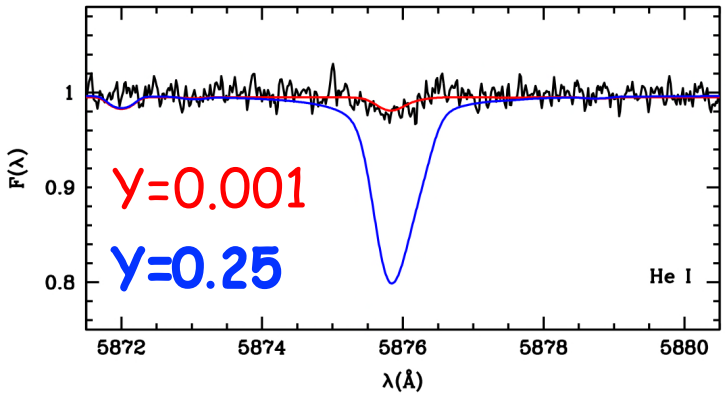


~ 8000 K

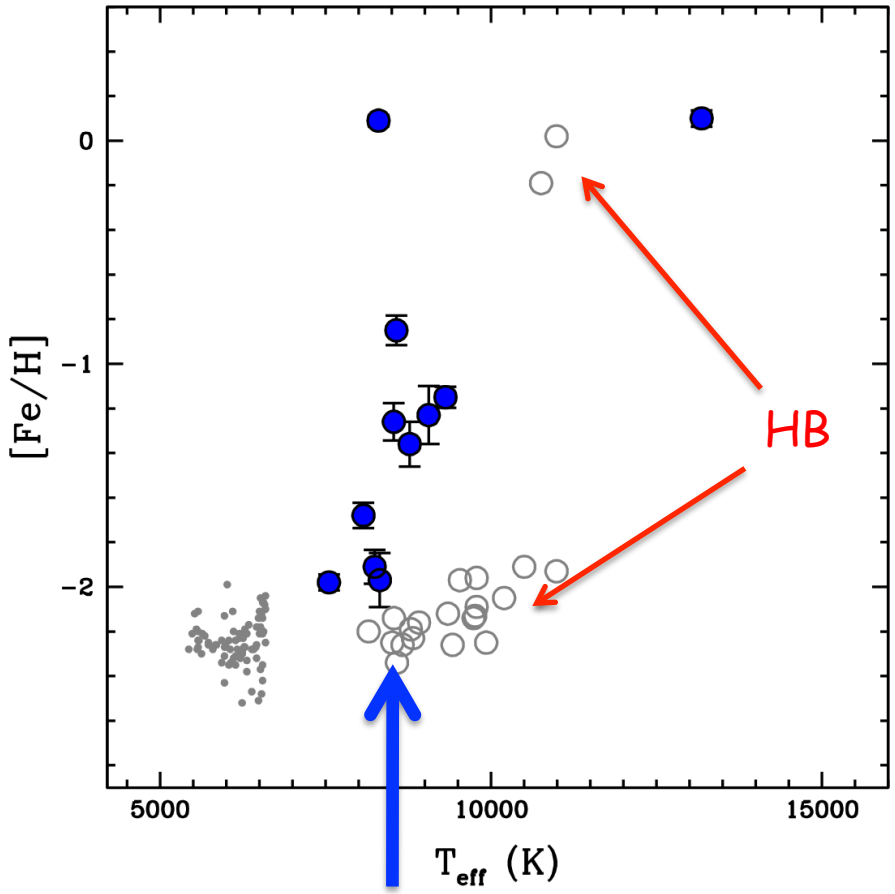
Radiative levitation:
observed in HB stars
with Teff> 11000 K



Gravitational settling of **He**



NGC 6397



~ 8000 K

First evidence of radiative levitation in BSS

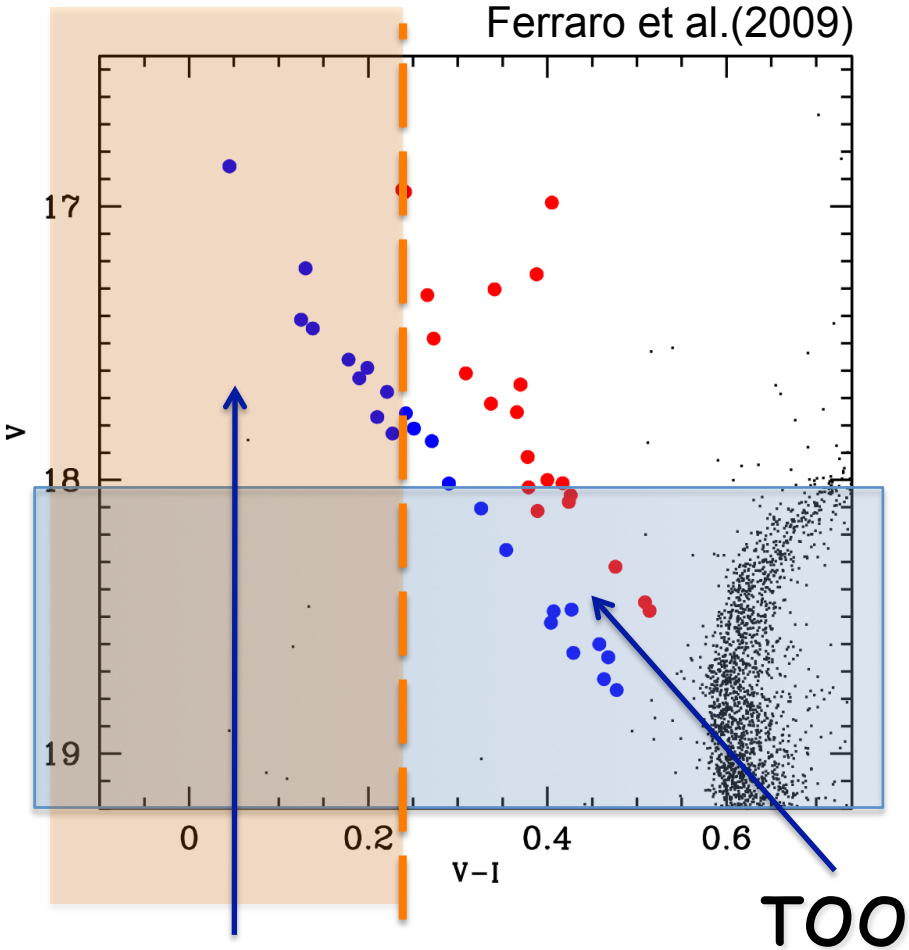
BAD LUCK !!!

We cannot study the true chemical composition of hot BSS

No information about C and O abundances

M30

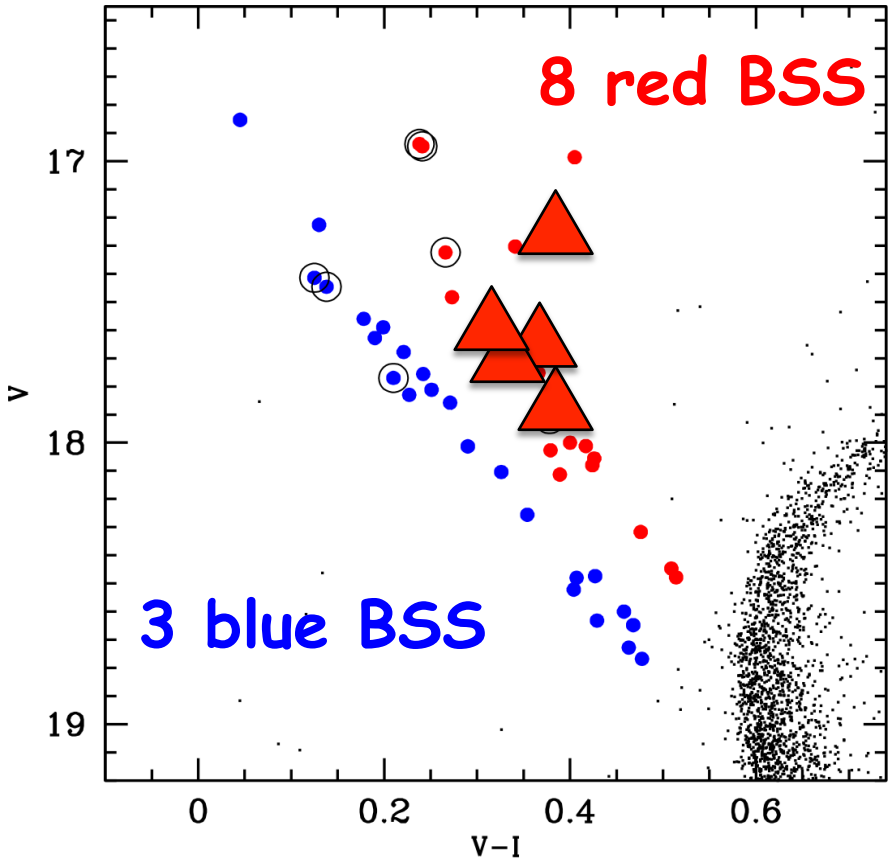
Chemical analysis for 11 BSS (Lovisi et al., in prep.)



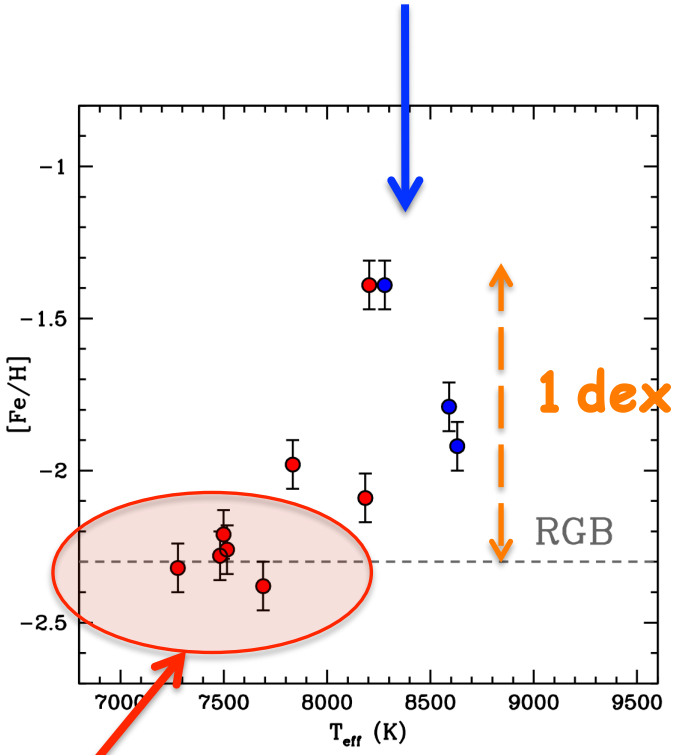
High-res spec for these BSS… a challenging task

- relatively faint
- hot (T>8000 K): levitation?
- Red BSS are centrally concentrated in the inner 30 arcsec

M30



Levitation



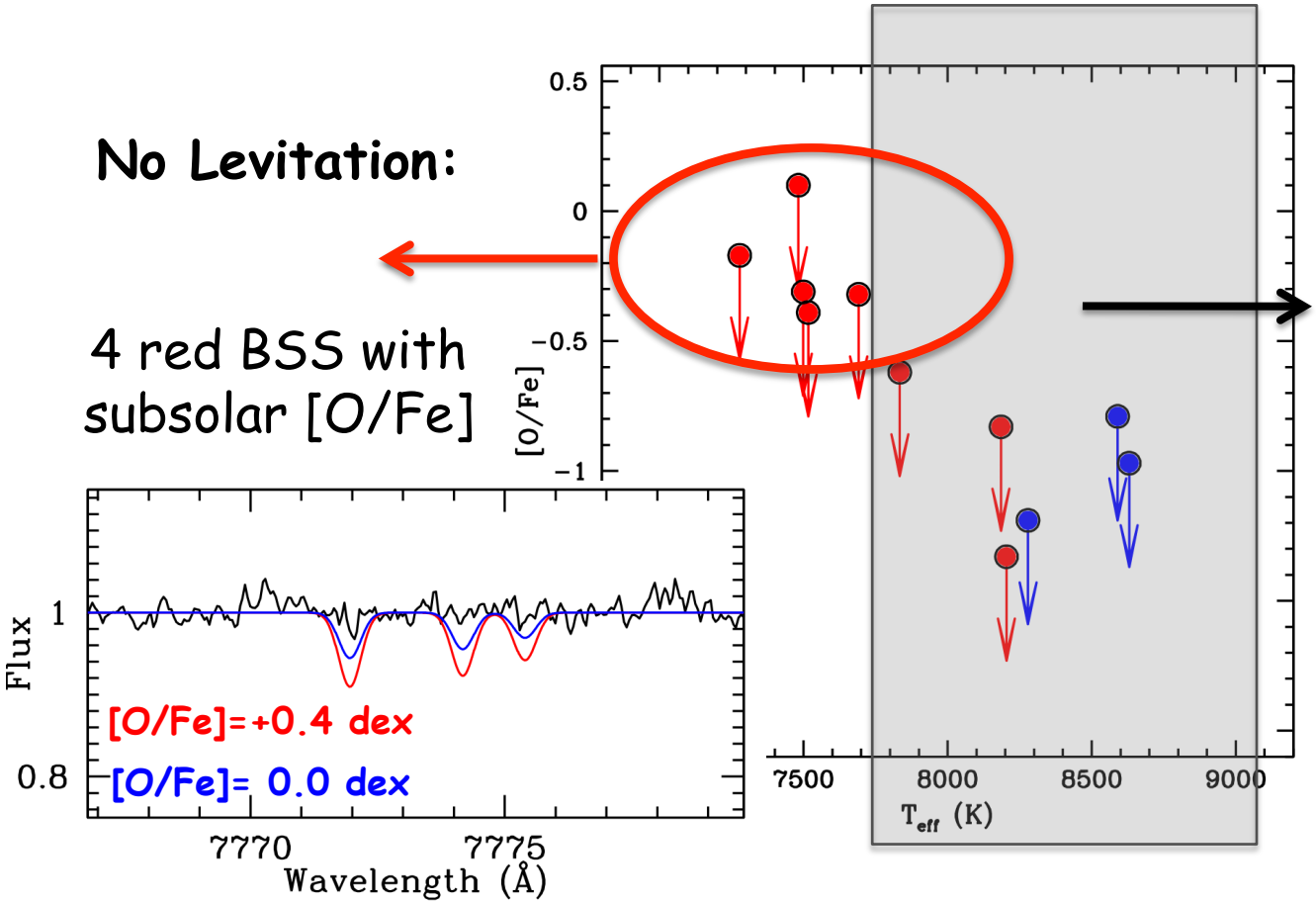
5 red BSS
without levitation

M30

Oxygen abundance: only upper limits but …

No Levitation:

4 red BSS with subsolar [O/Fe]

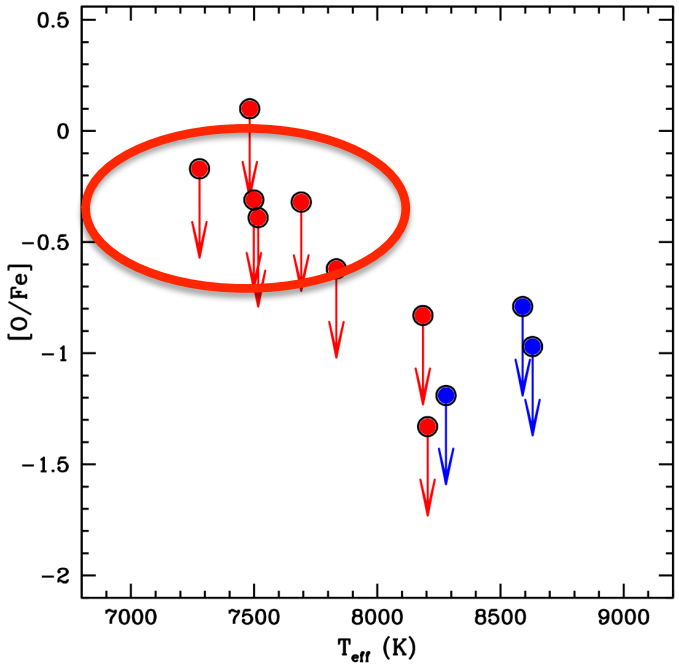


Levitation:
no reliable clues to oxygen abundances

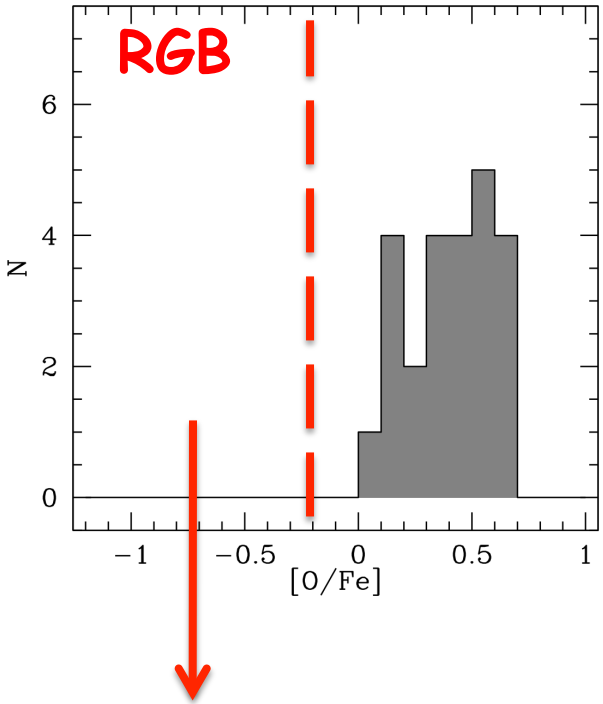
M30

Red BSS: [O/Fe] < -0.3 dex

(No information about C)



Carretta et al.(2010)



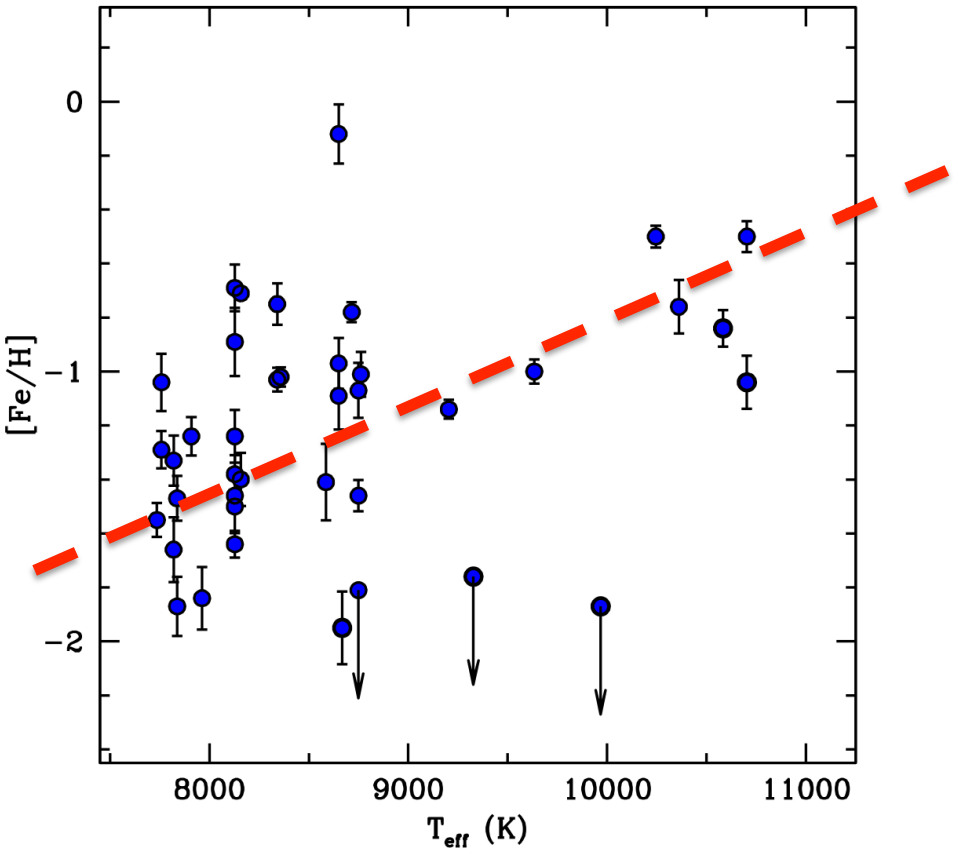
Incompatible with the [O/Fe] distribution of the cluster

Hint of mass transfer in the red BSS

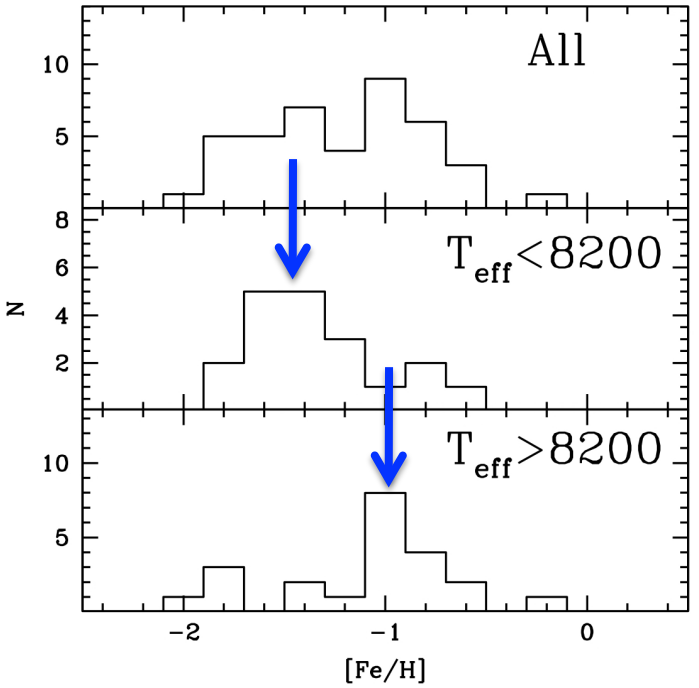
Omega Cen

Chemical analysis for 43 BSS
(Mucciarelli et al., in prep.)

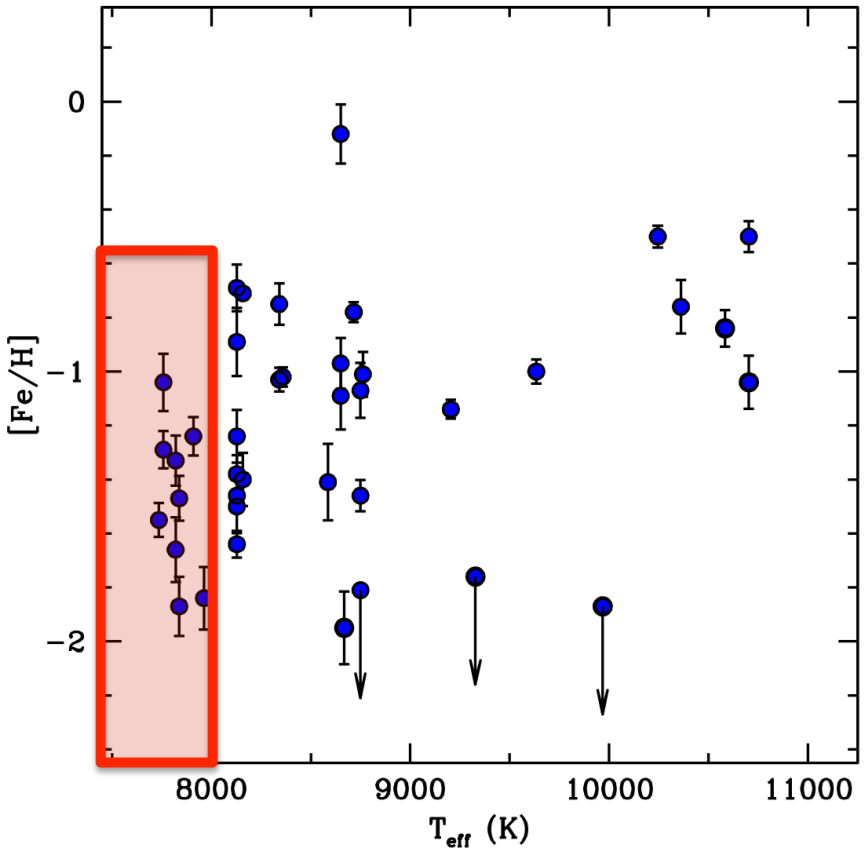
[Fe/H] increases increasing Teff

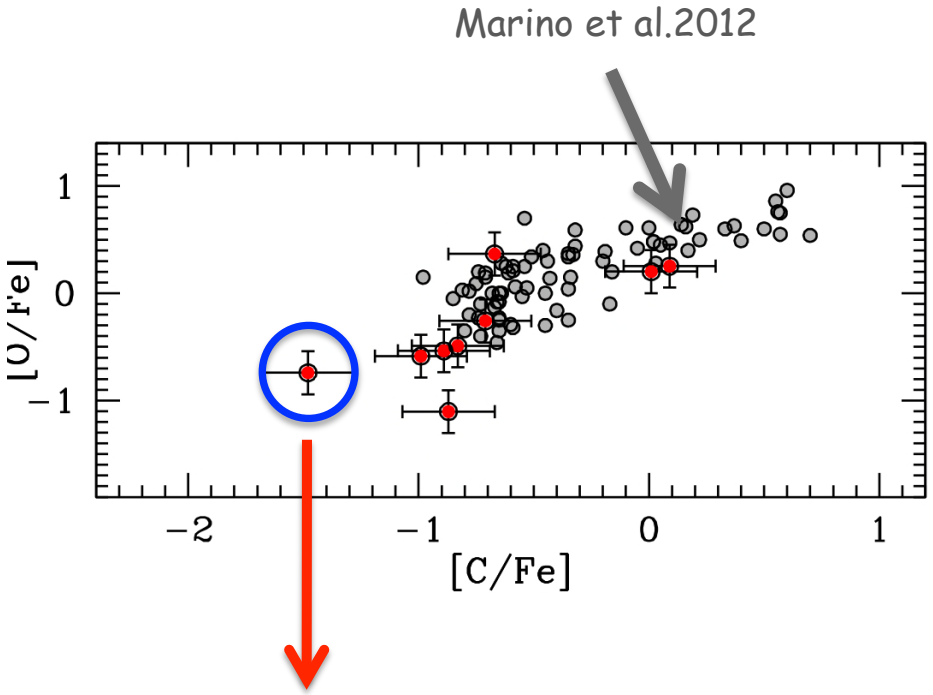


Radiative Levitation



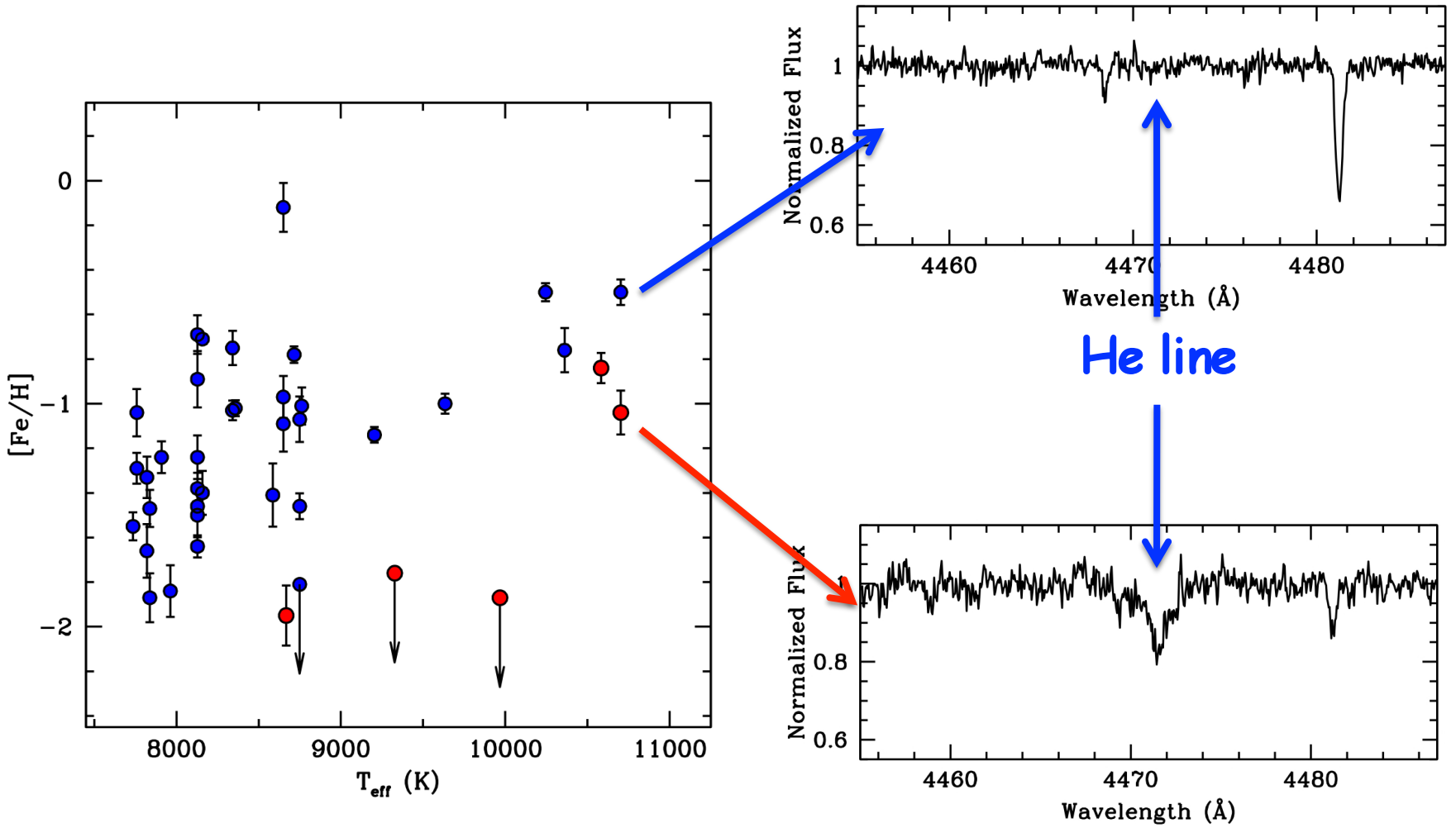
Omega Cen


0
−1
−2
[Fe/H]
8000
9000
10000
11000
T_{eff} (K)


Marino et al.2012
1
0
−1
[O/Fe]
−2
−1
0
1
[C/Fe]
C-poor BSS

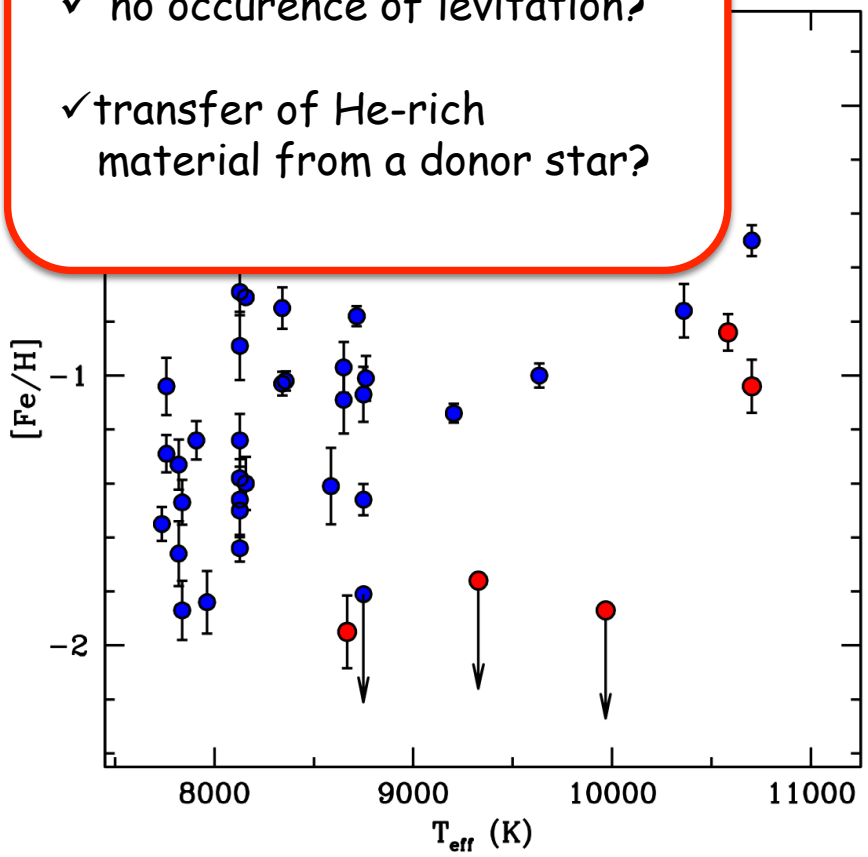
Omega Cen

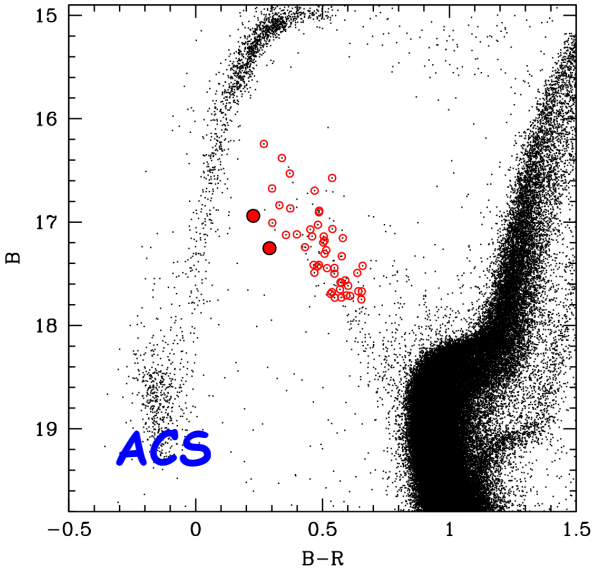
5 anomalous BSS

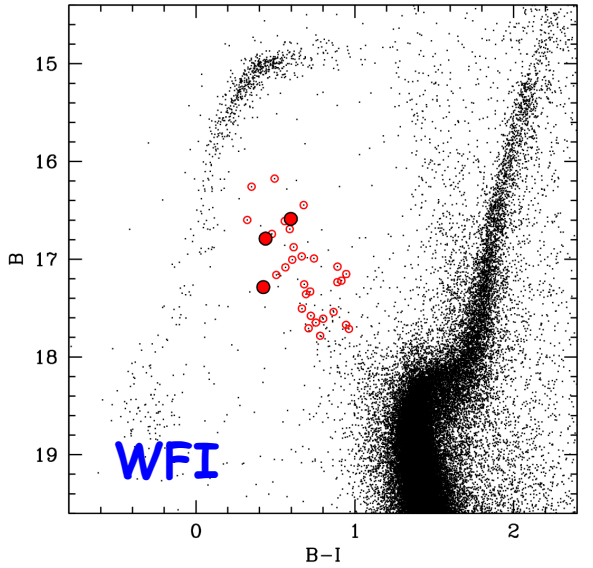


Omega Cen

- ✓ no occurence of levitation?
- ✓ transfer of He-rich material from a donor star?







Summarysing…

47 Tuc M30 (red)	CO-depletion	mass transfer?
M4	No CO-depleted BSS (statistical problems ?)	
NGC 6397 M30 (blue)	Radiative levitation (no information about C and O)	
Omega Cen	Radiative levitation 1 (suspected) C-poor BSS 5 anomalous He-rich BSS	

Visit our web-site: **www.cosmic-lab.eu**

The End