



Publication Year	2015
Acceptance in OA	2020-03-17T14:37:26Z
Title	Stellar abundances in clusters: High-resolution, multi-object spectroscopy of globular & open clusters in the Milky Way
Authors	BRAGAGLIA, Angela
Handle	http://hdl.handle.net/20.500.12386/23330

STELLAR ABUNDANCES in CLUSTERS

High-resolution, multi-object spectroscopy of
globular & open clusters in the Milky Way

Angela Bragaglia

INAF-Oss. Astronomico Bologna



There are more surveys in heaven and earth, Horatio...

- large scale

Gaia-ESO public spectroscopic survey

P. Donati, D. Romano, M. Tosi, L. Magrini, S. Randich,
T. Cantat Gaudin, R. Sordo, A. Vallenari, E. Friel, H. Jacobson
& *GES Consortium* (400+)

- “private”

FLAMES GC program

E. Carretta, V. D'Orazi, R. Gratton, S. Lucatello,
A. Sollima, C. Sneden

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PRIN-MIUR 2010-11 :

“The chemical and Dynamical Evolution of the Milky
Way and Local Group Galaxies” (PI F. Matteucci)

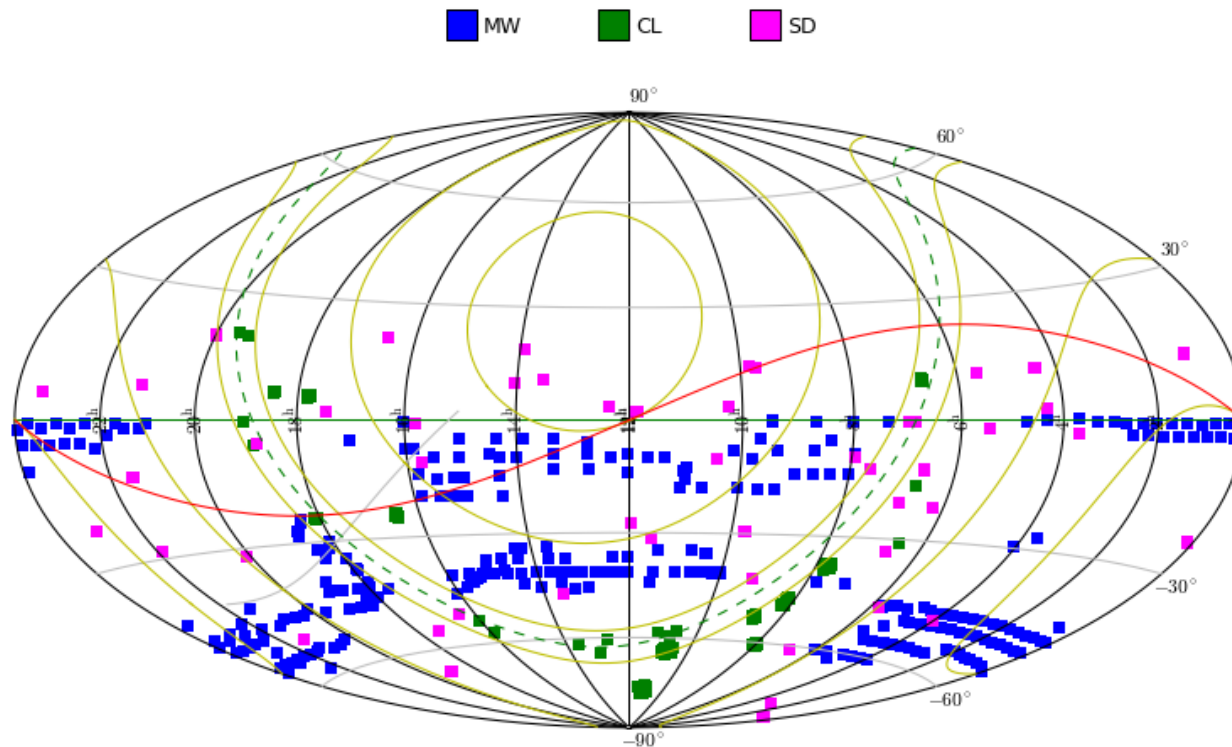
- “private”

FLAMES GC program

E. Carretta, V. D'Orazi, R. Gratton, S. Lucatello,

A. Sollima, C. Sneden

The Gaia-ESO Survey in a nutshell



- PI Randich/Gilmore
- 400+ researchers
- 300 VLT nights/5 years
(3 yrs / 32 obs runs)
- FLAMES
- 10^5 MW stars
- 70+ open clusters
(~30 observed)
- STD / GCs
- distributed analysis

For information : <http://www.gaia-eso.eu>

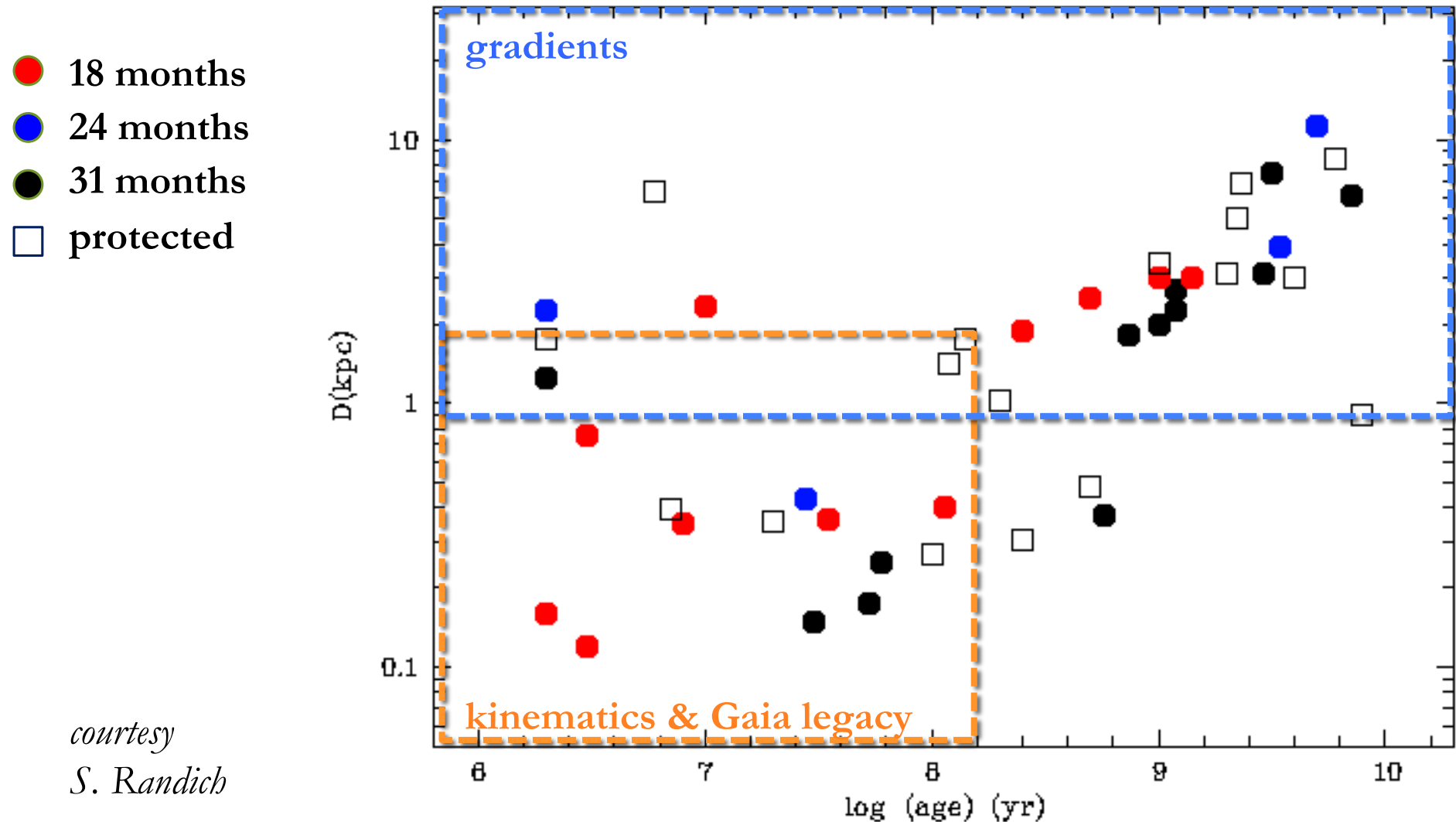


The Gaia-ESO Survey – open clusters

core science

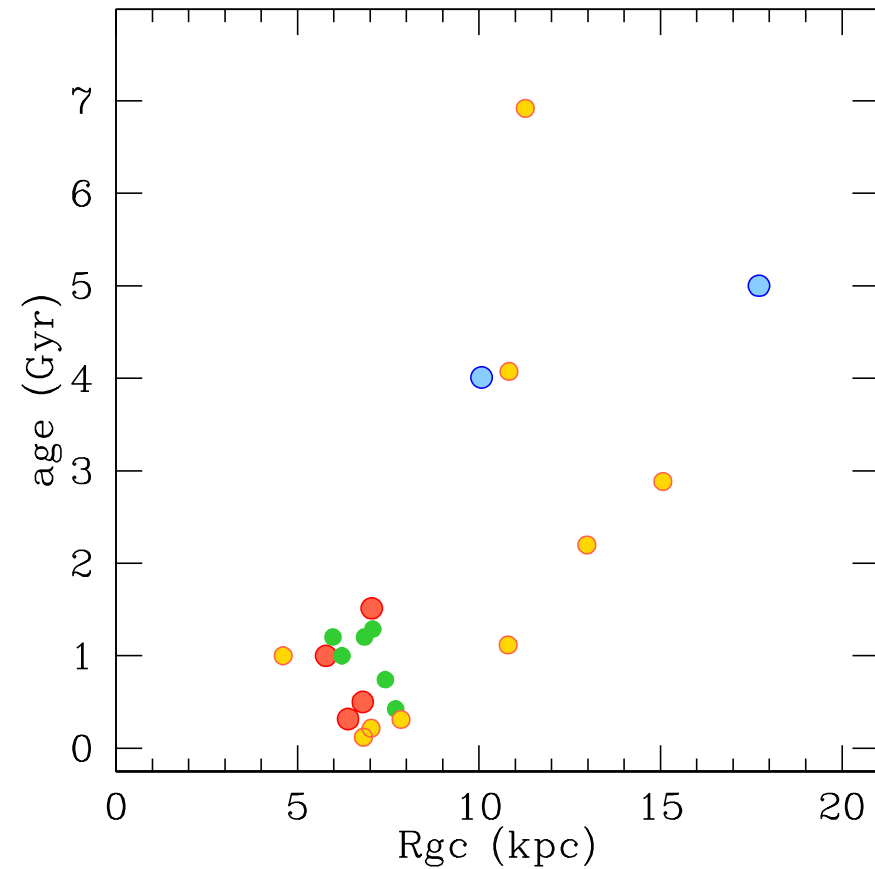
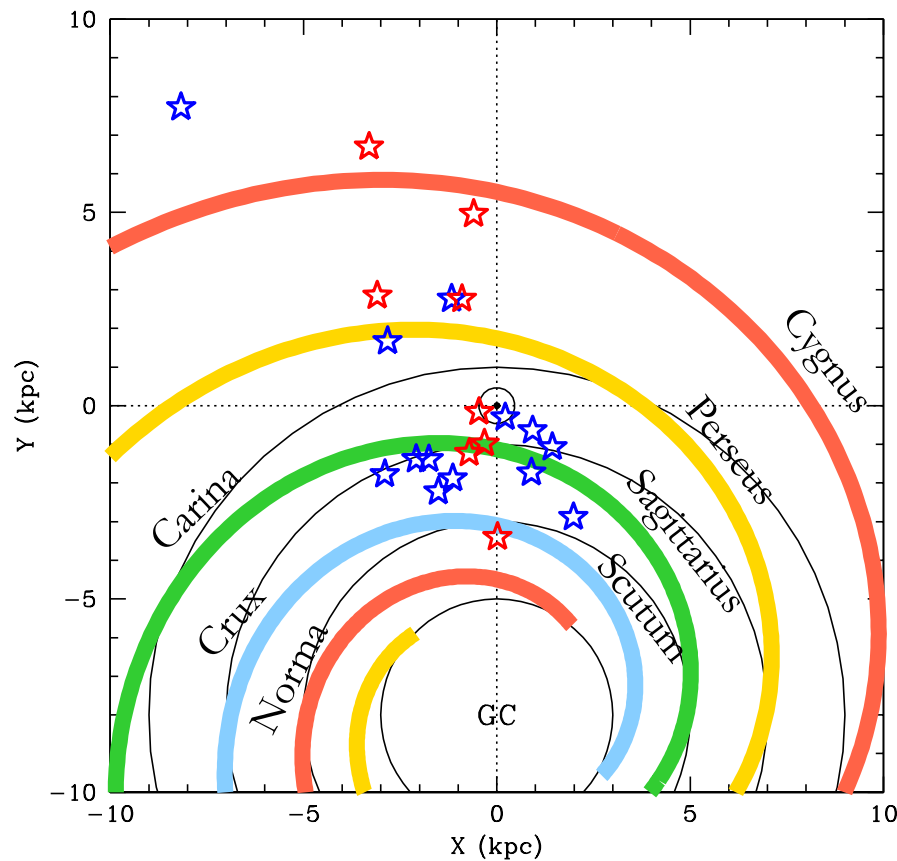
- Open cluster formation & dynamics
- Properties & evolution of MW disk
- Stellar evolution

The Gaia-ESO Survey – all OCs

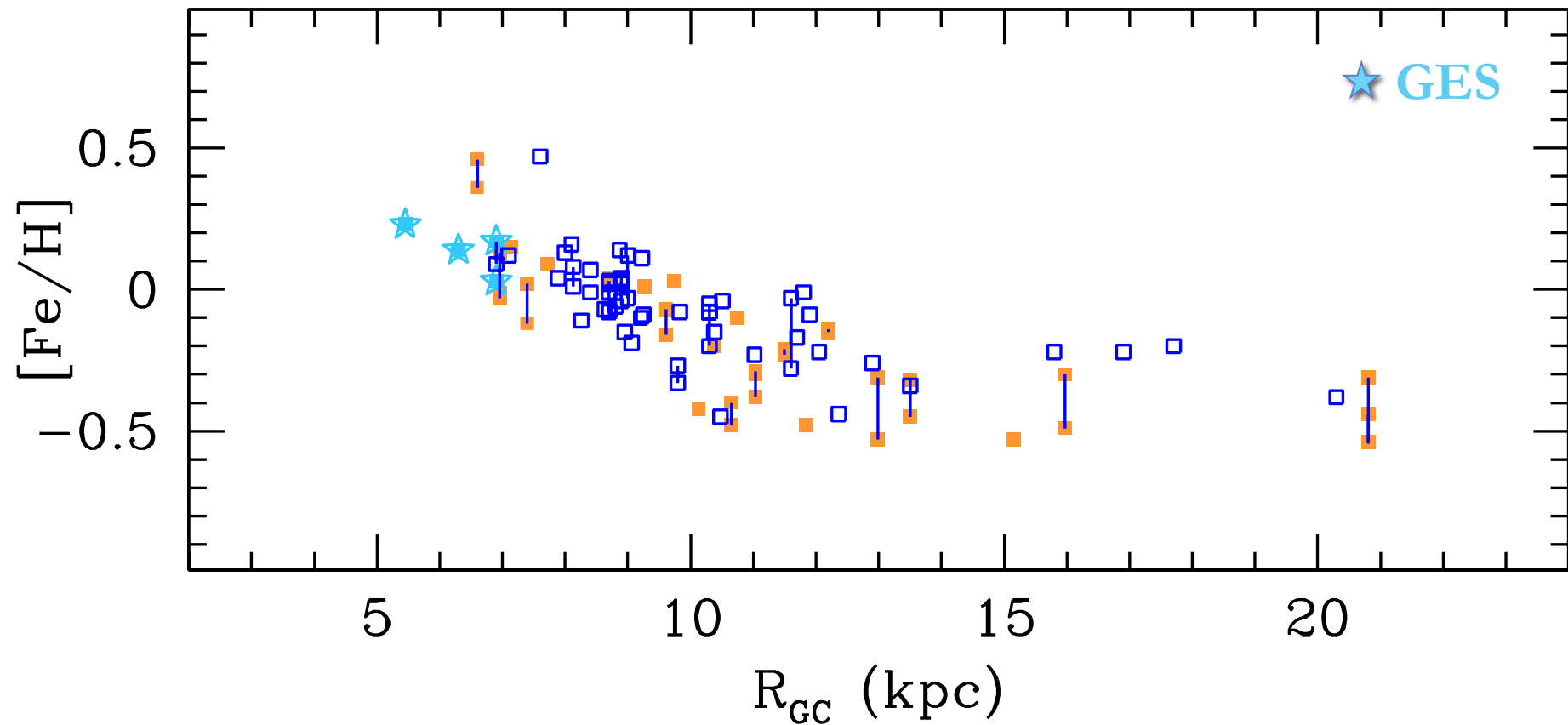


courtesy
S. Randich

The Gaia-ESO Survey – old OCs

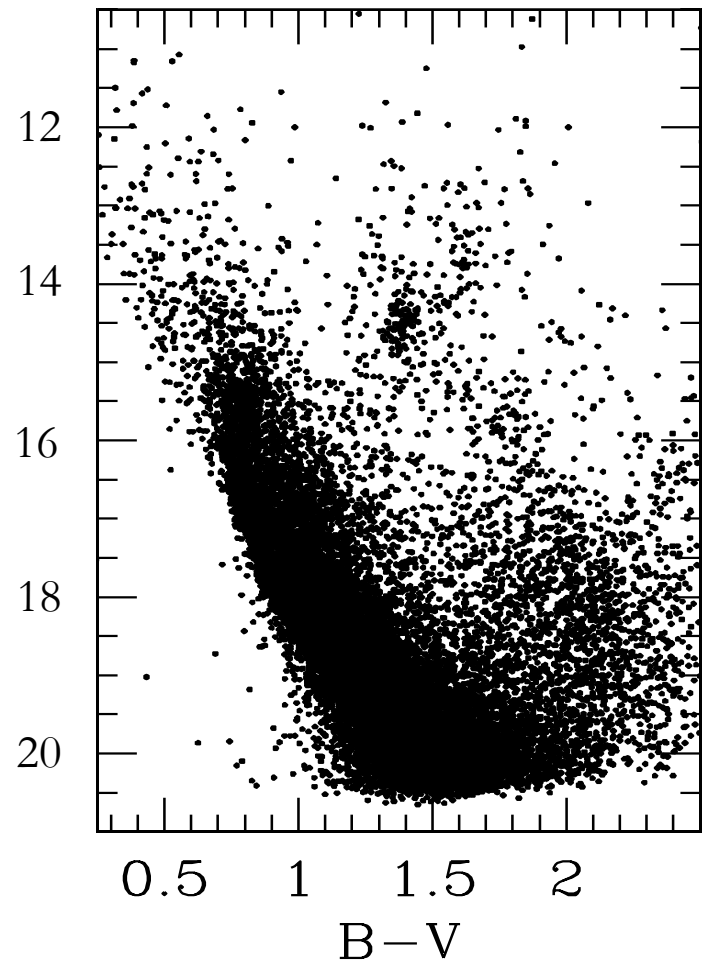


The Gaia-ESO Survey – old OCs

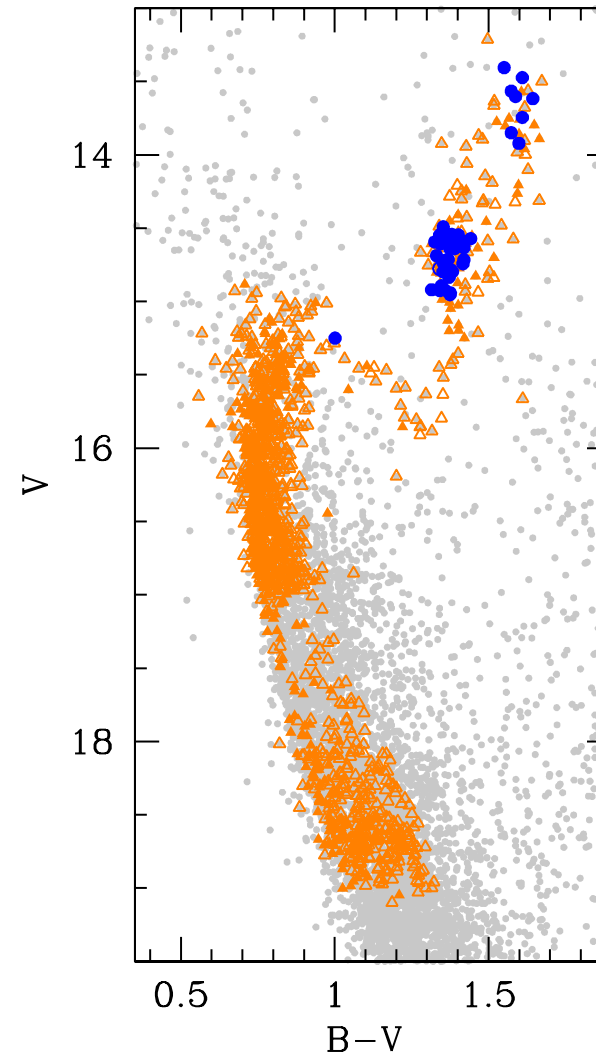


Yong+2012 & literature $[Fe/H]$ after 2012 ; BOCCE age, R_{gc} if available

The Gaia-ESO Survey – Trumpler 20

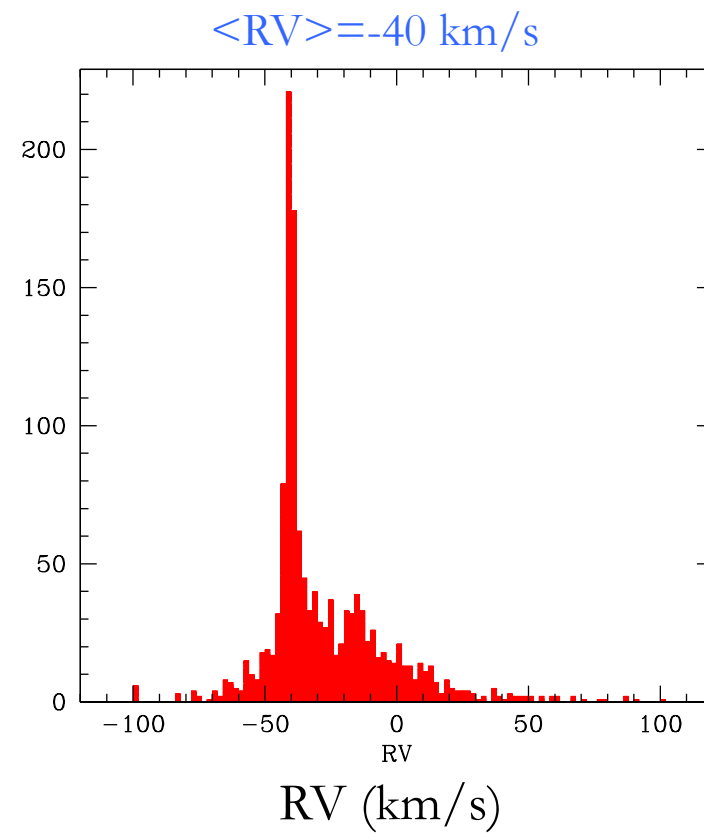
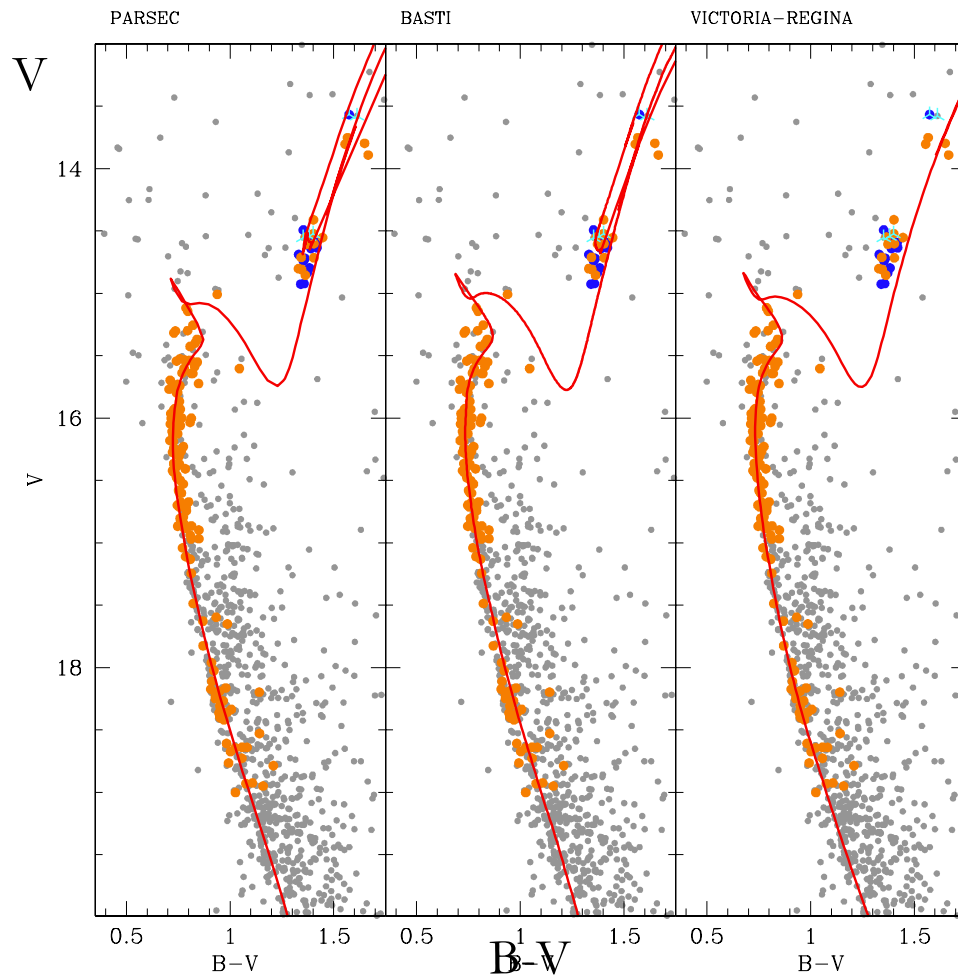


Carraro+2010



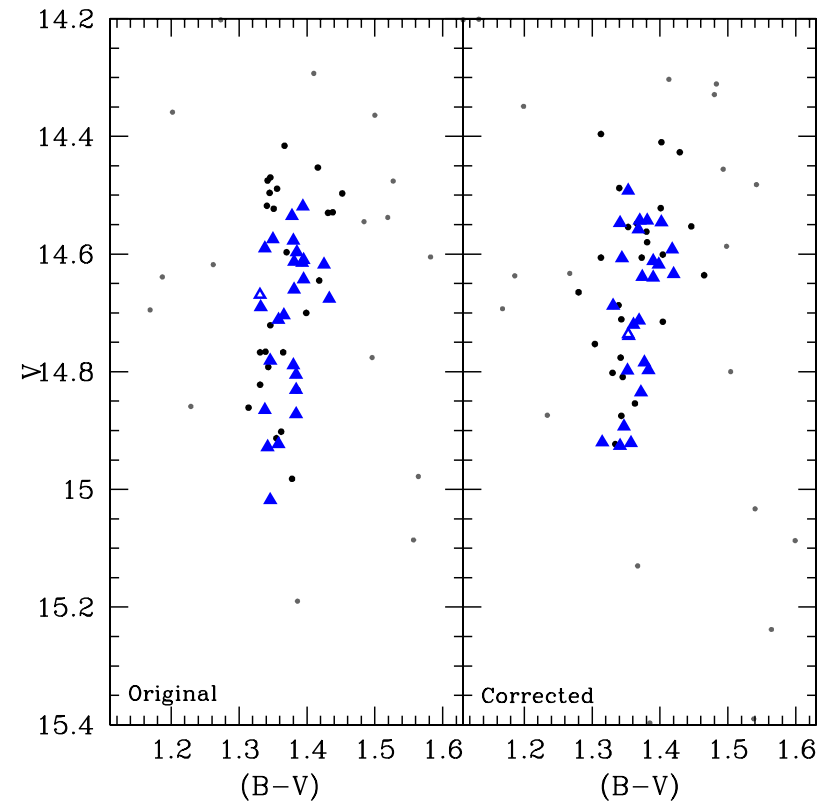
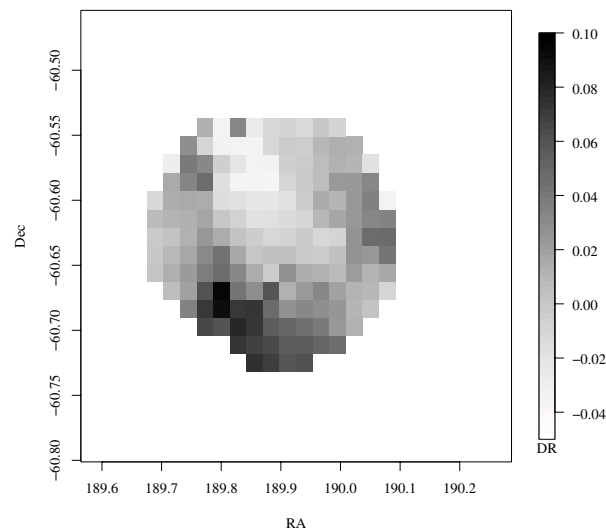
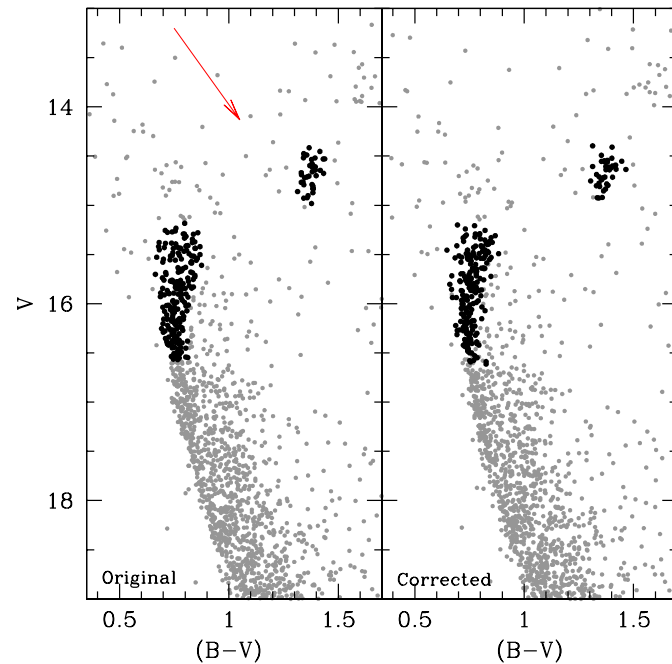
GES - Donati+ 2014

The Gaia-ESO Survey – Trumpler 20



GES - Donati+ 2014 : ~40% M

The Gaia-ESO Survey – Trumpler 20



“golf-club” MSTO
elongated/double RC

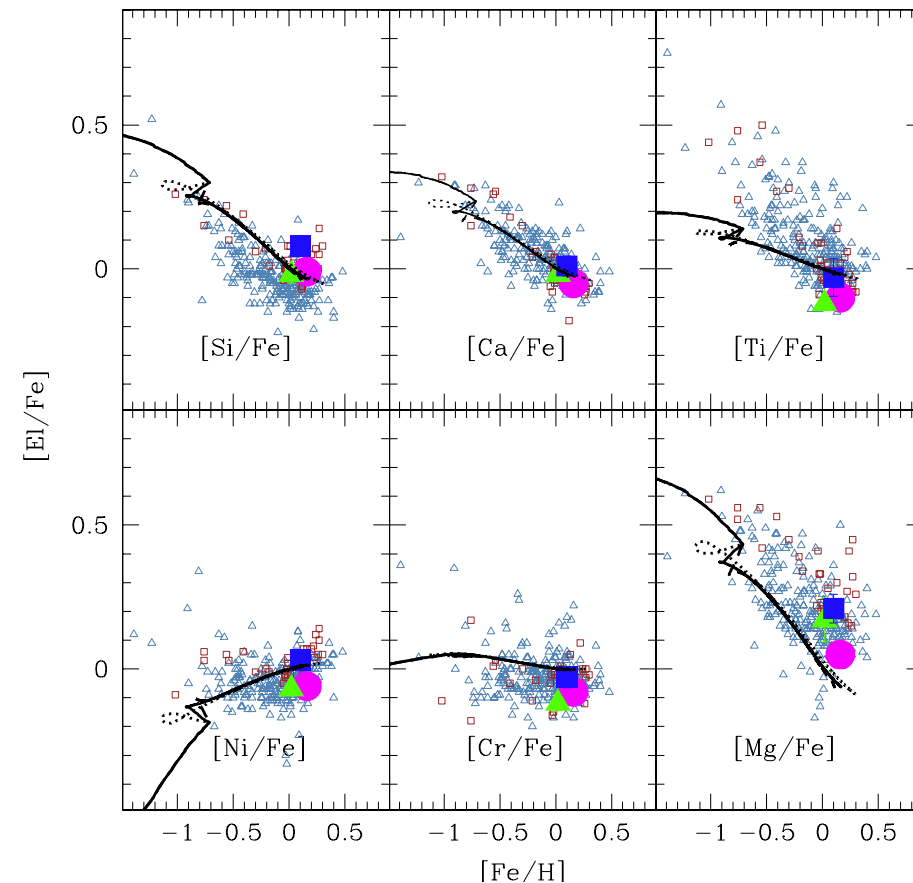
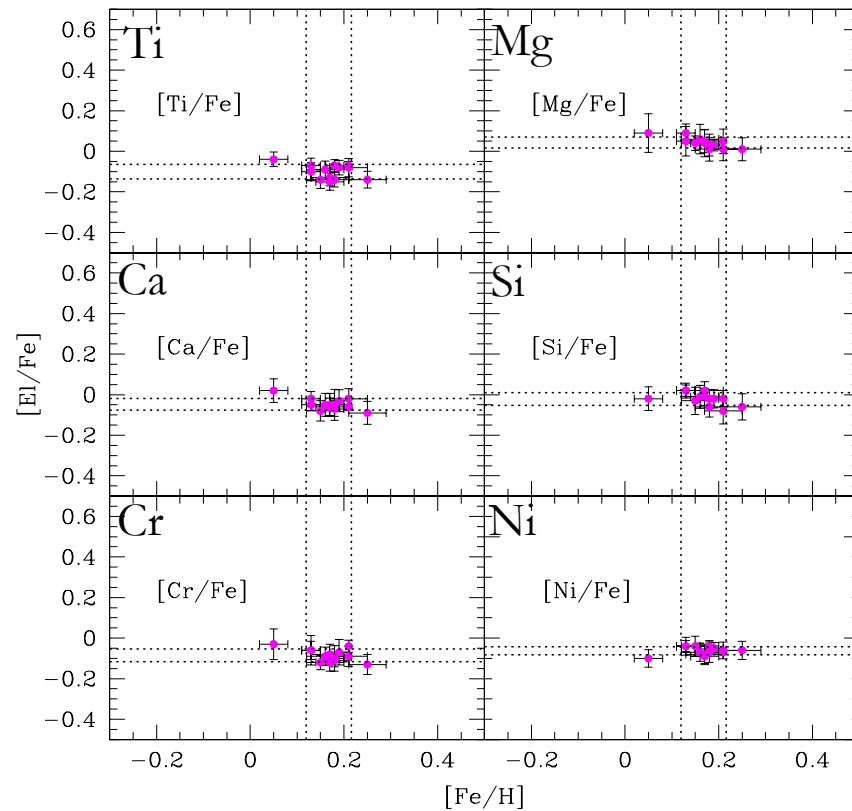
The Gaia-ESO Survey – inner disk OCs

OC	age	Rgc	RV	[Fe/H]	GES paper
Tr 20	1.5	6.9	−40.5 (1470)	+0.16 (13)	Donati+2014
NGC4815	0.5	6.9	−30.2 (218)	+0.03 (5)	Friel+2014
NGC6705	0.3	6.3	+34.5 (1053)	+0.10 (21)	Cantat-Gaudin+2014
Be 81	1.0	5.5	+47.6 (280)	<i>in progress</i>	<i>in progress</i>
NGC6208	0.7	7.4			<i>observed</i>
Be 44	1.3	7.1			<i>observed</i>
Pismis 18	1.2	6.8			<i>observed</i>
Tr 23	1.0	6.2			<i>observed</i>
NGC6005	1.2	6.0			<i>observed</i>

RV : GIRAFFE+UVES - [FE/H] : UVES

for more details, see talk by Laura Magrini (on Tuesday)

The Gaia-ESO Survey – 3 inner disk OCs



— chemev models *Romano+2010*

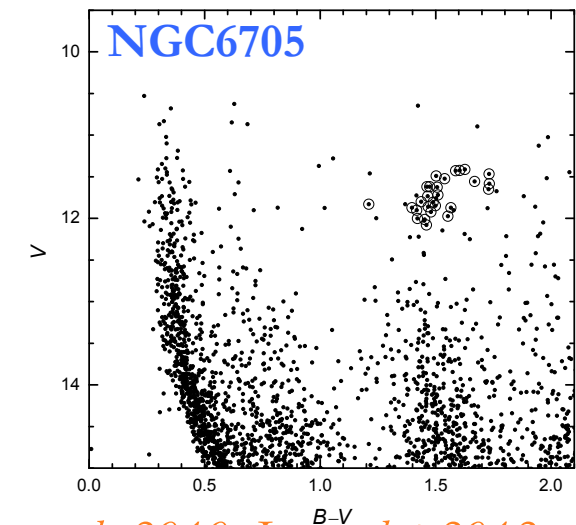
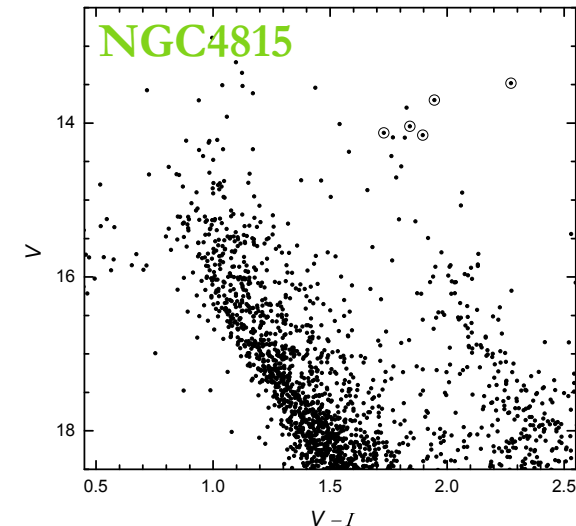
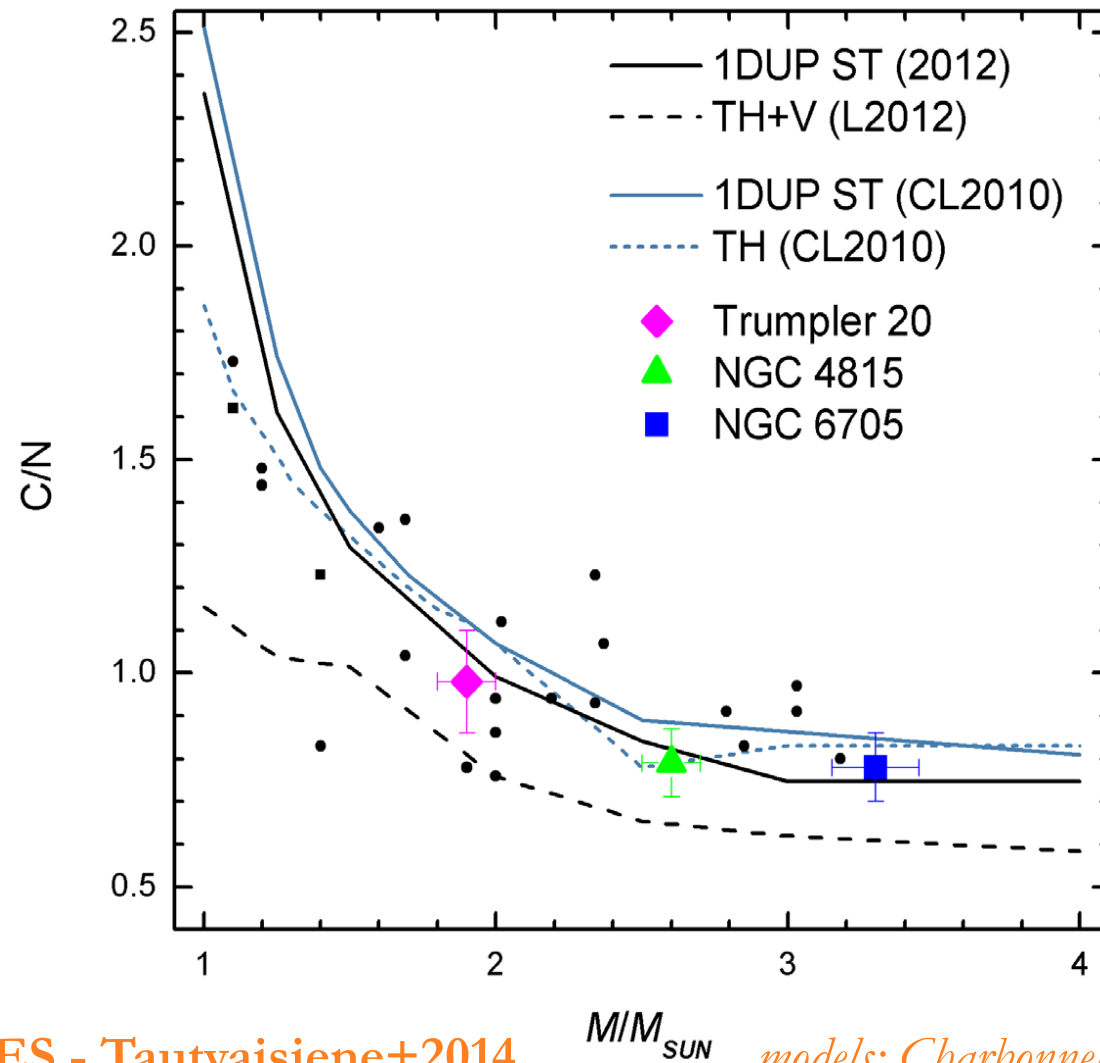
Trumpler 20

NGC4815

M11

GES - Magrini+ 2014

The Gaia-ESO Survey – 3 inner disk OCs



GES - Tautvaisiene+2014

M/M_{SUN}

models: Charbonnel&Lagarde 2010, Lagarde+2012

End of first act ...

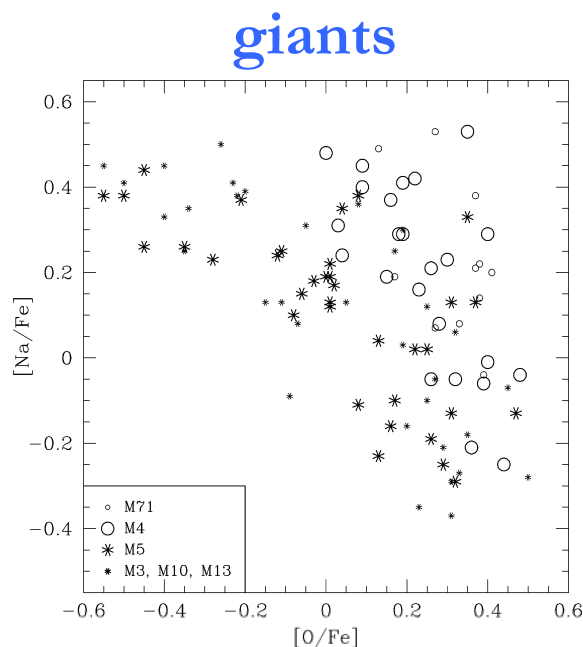
Open clusters :

- information on Galactic disk
 - e.g. structure*
 - e.g. chemical evolution*
- test of stellar models
 - e.g., tracks*
 - e.g., mixing mechanisms*
- homogenous clusters (single populations)

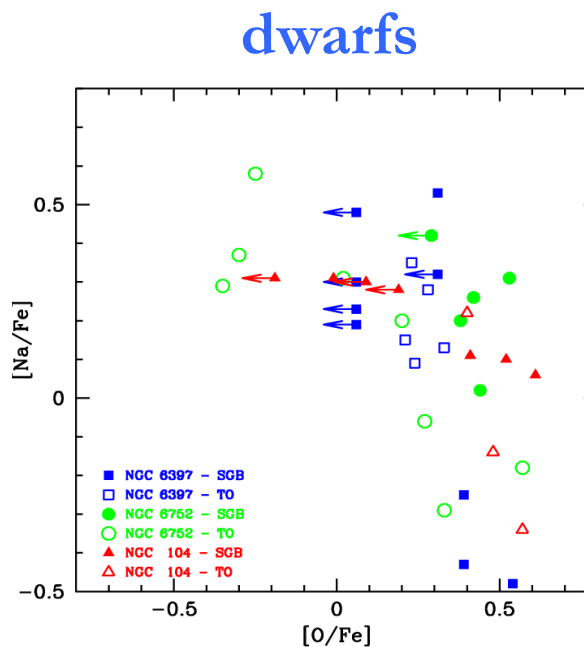
GCs: setting the stage

In GCs light elements show
star-to-star variations

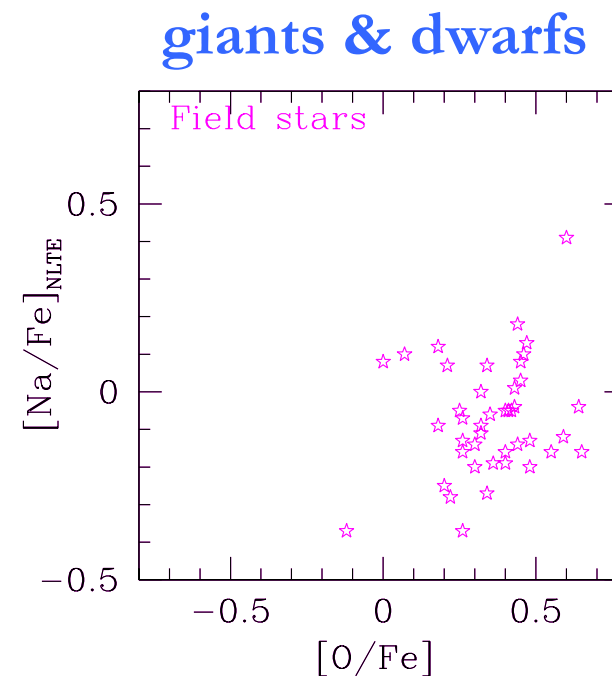
In field stars they
do not



ARA&A 2004
~400 stars
~20 GCs



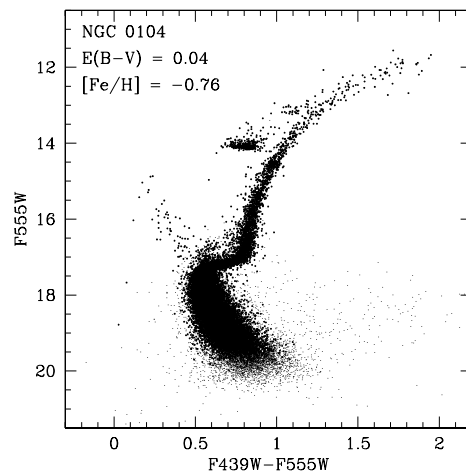
NGC6397, NGC6752, 47Tuc:
Gratton+ 2001 ; Carretta+ 2004



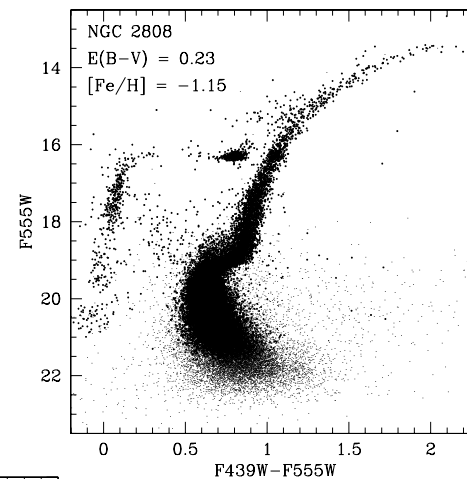
Field stars (*Gratton+ 2000*)

Our sample of clusters

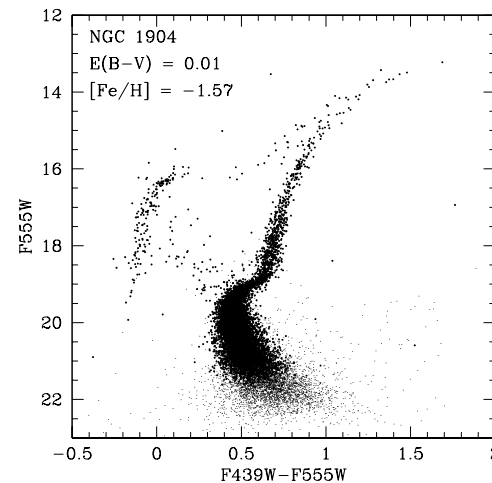
- 24 massive GCs : $M_V = -5.5$ to -10



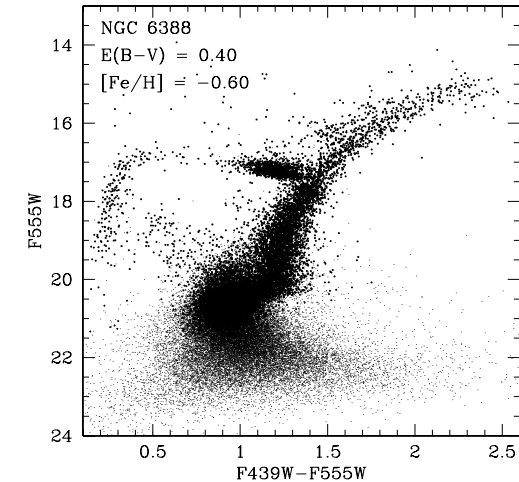
47Tuc



NGC2808



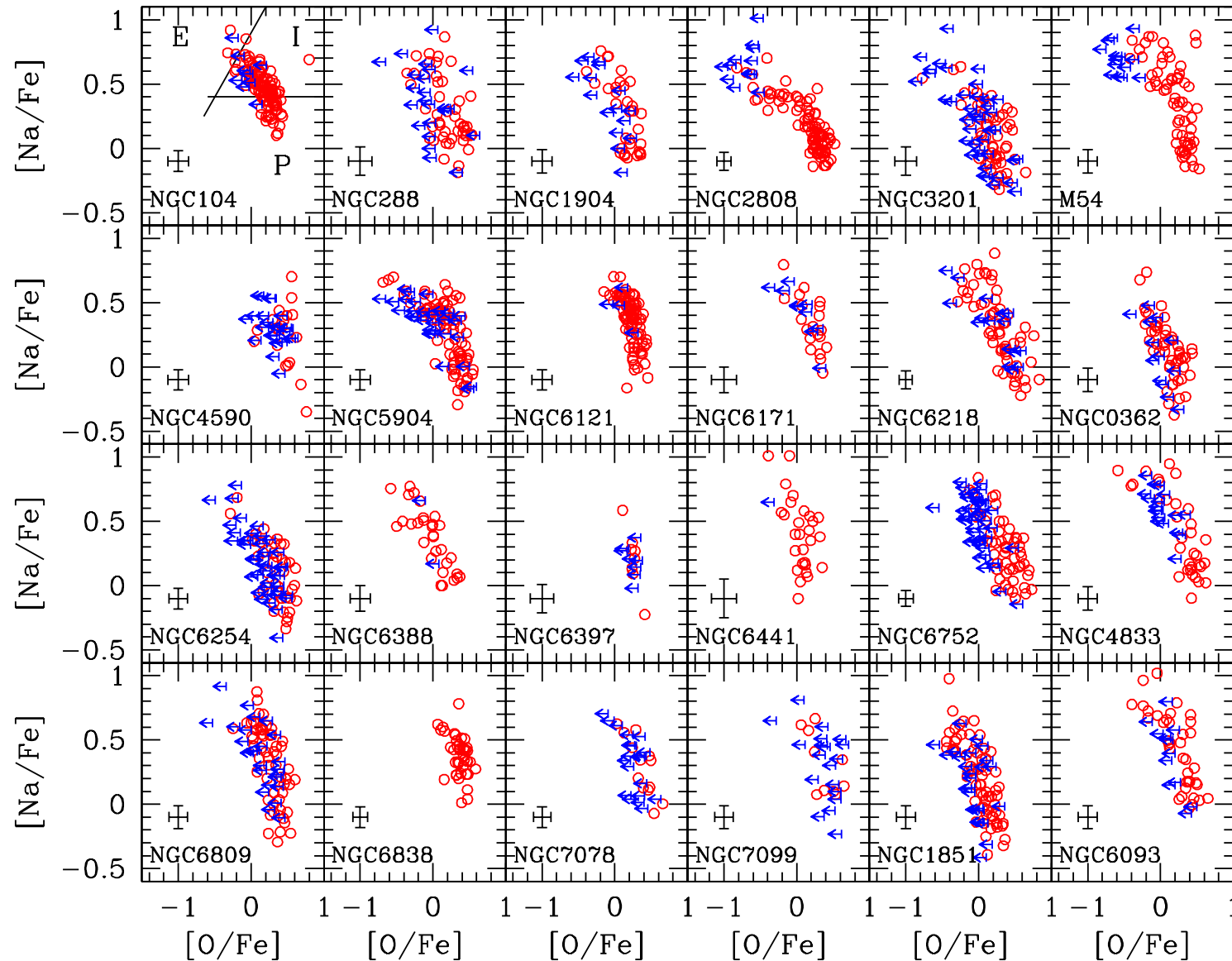
NGC1904



NGC6388

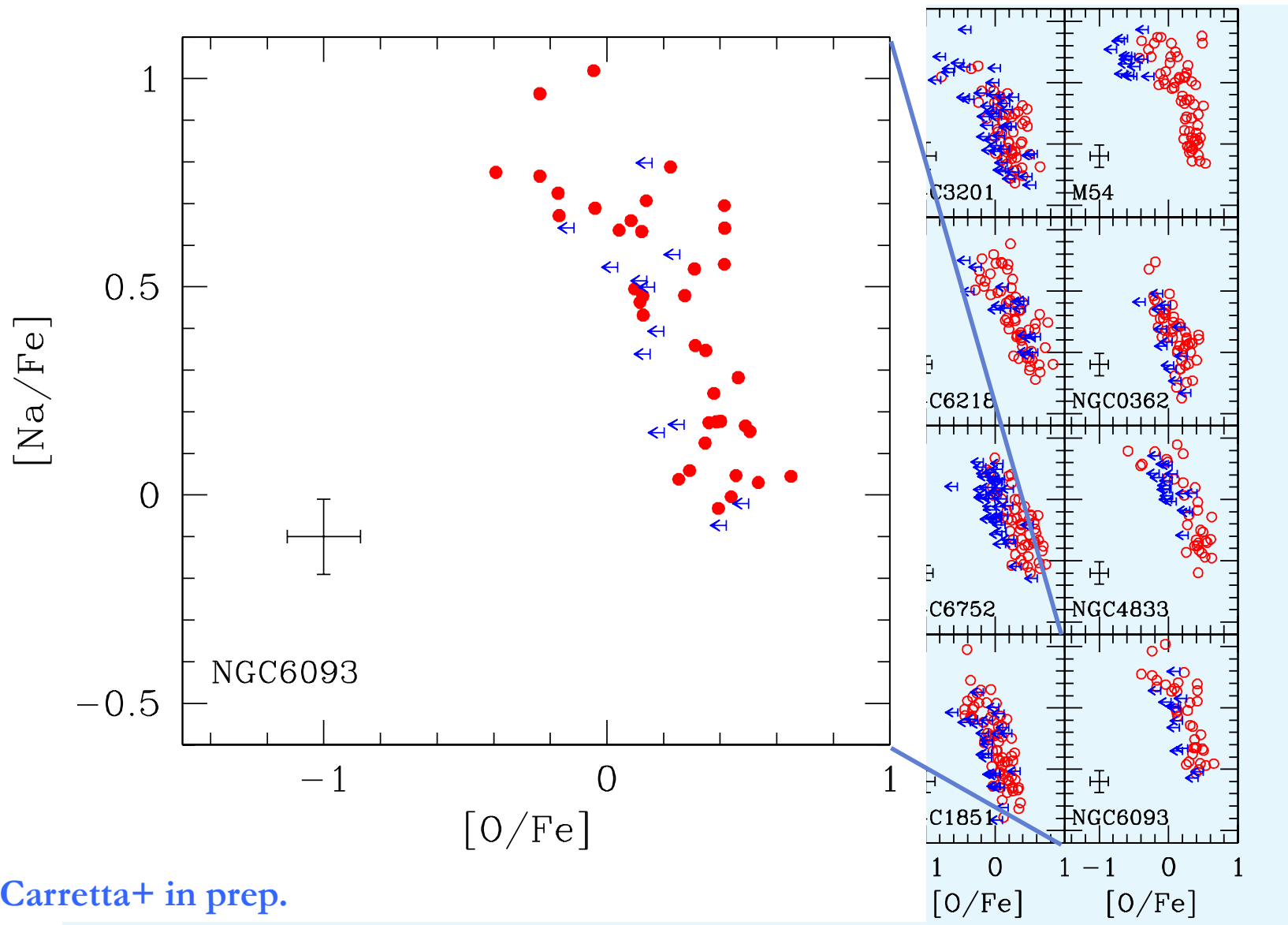
*Piotto+2002,
HST snapshot*

GCs: Na & O in RGB stars

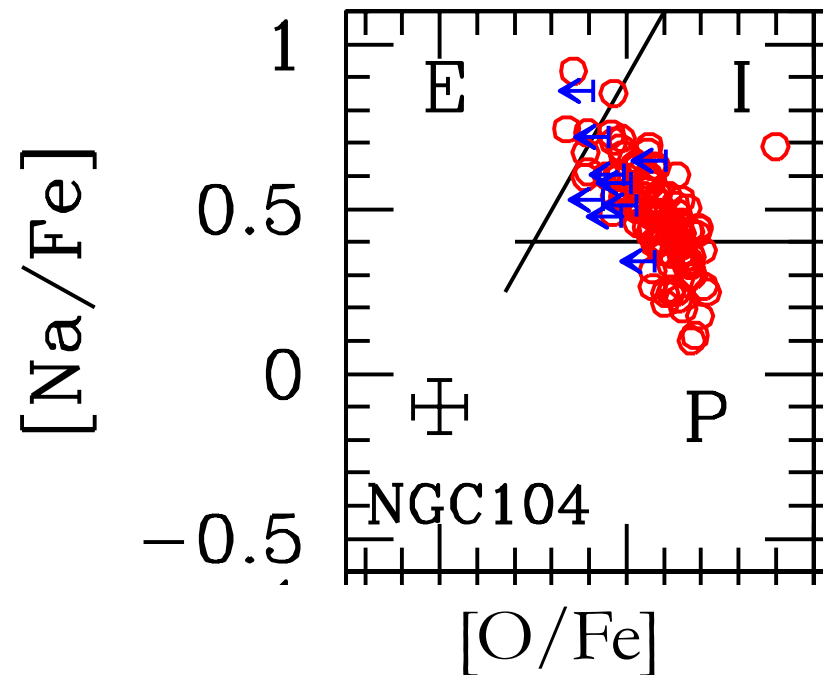


Carretta+
2009,2010,
2011,2013,
2014, ...

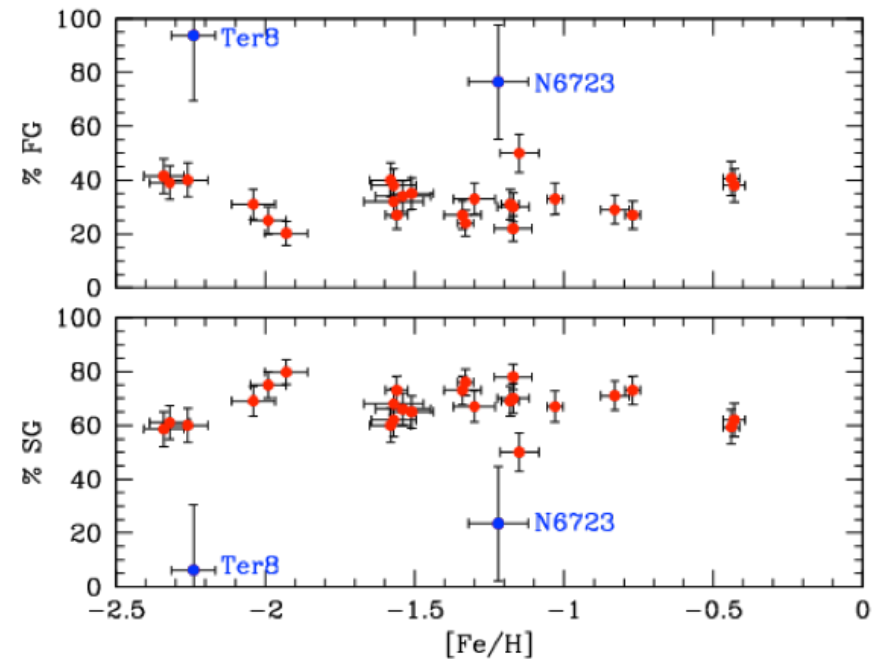
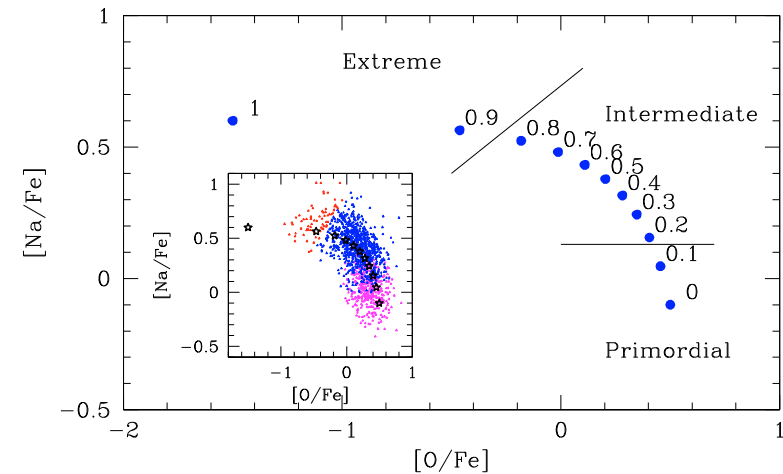
GCs: Na & O in RGB stars



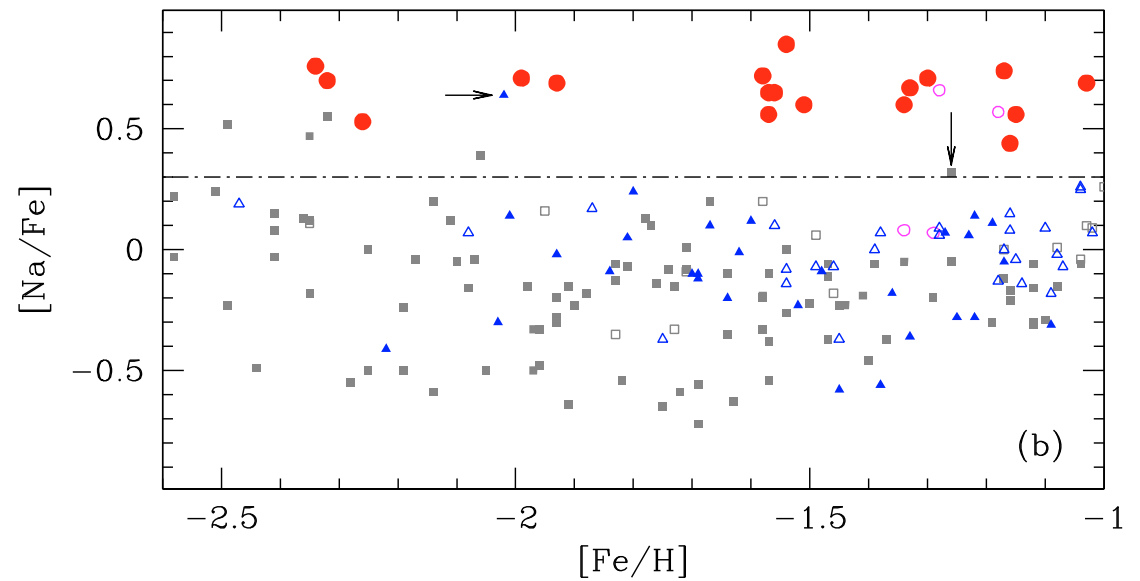
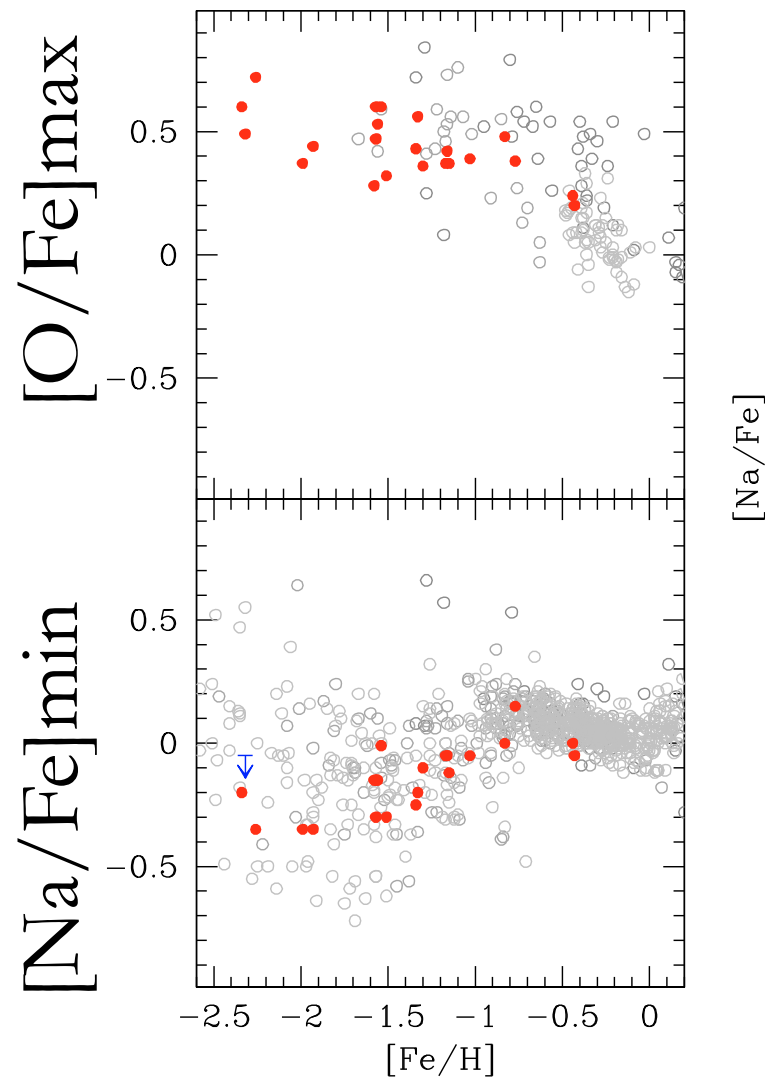
GCs: Na & O in RGB stars



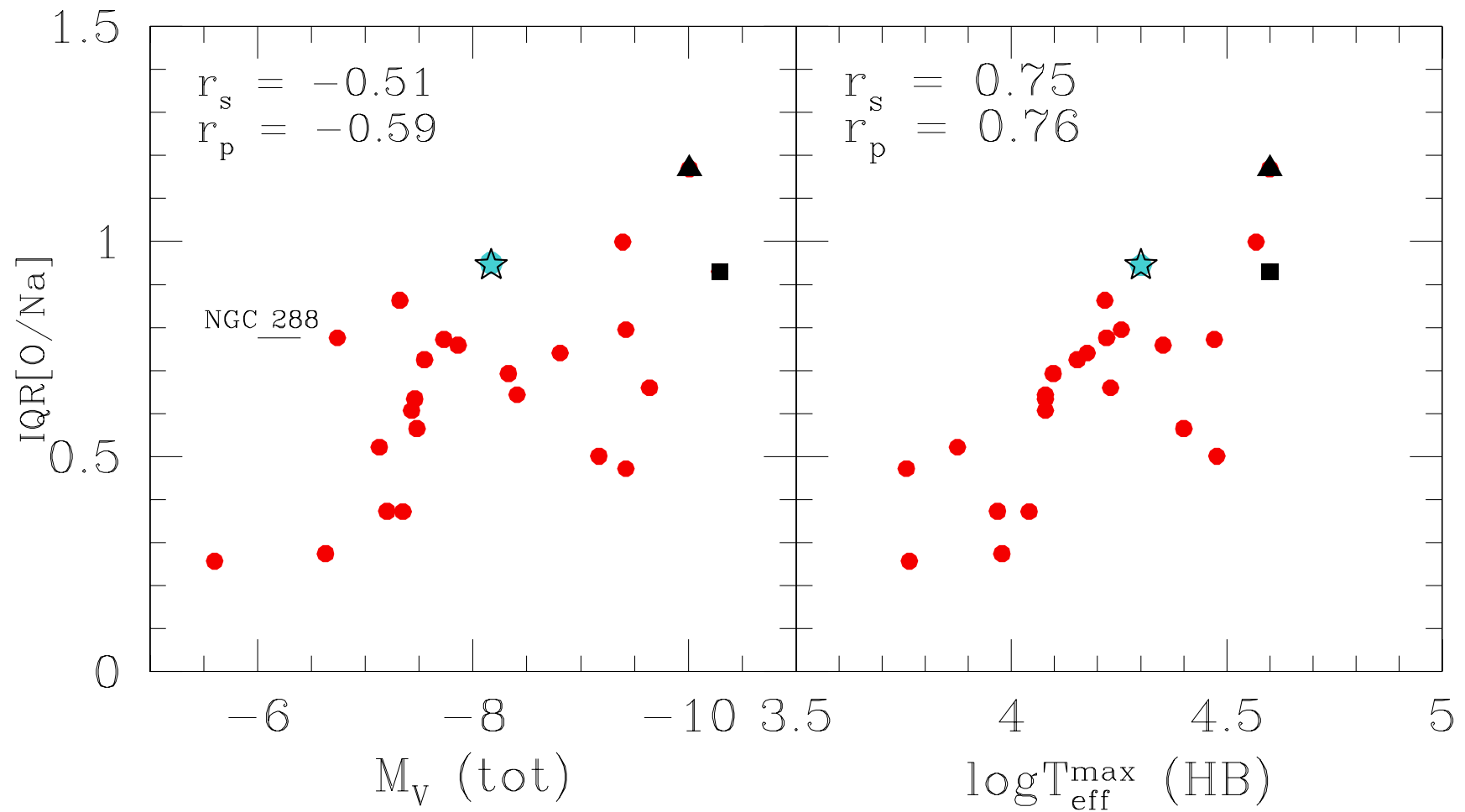
FG : P
SG : I+E



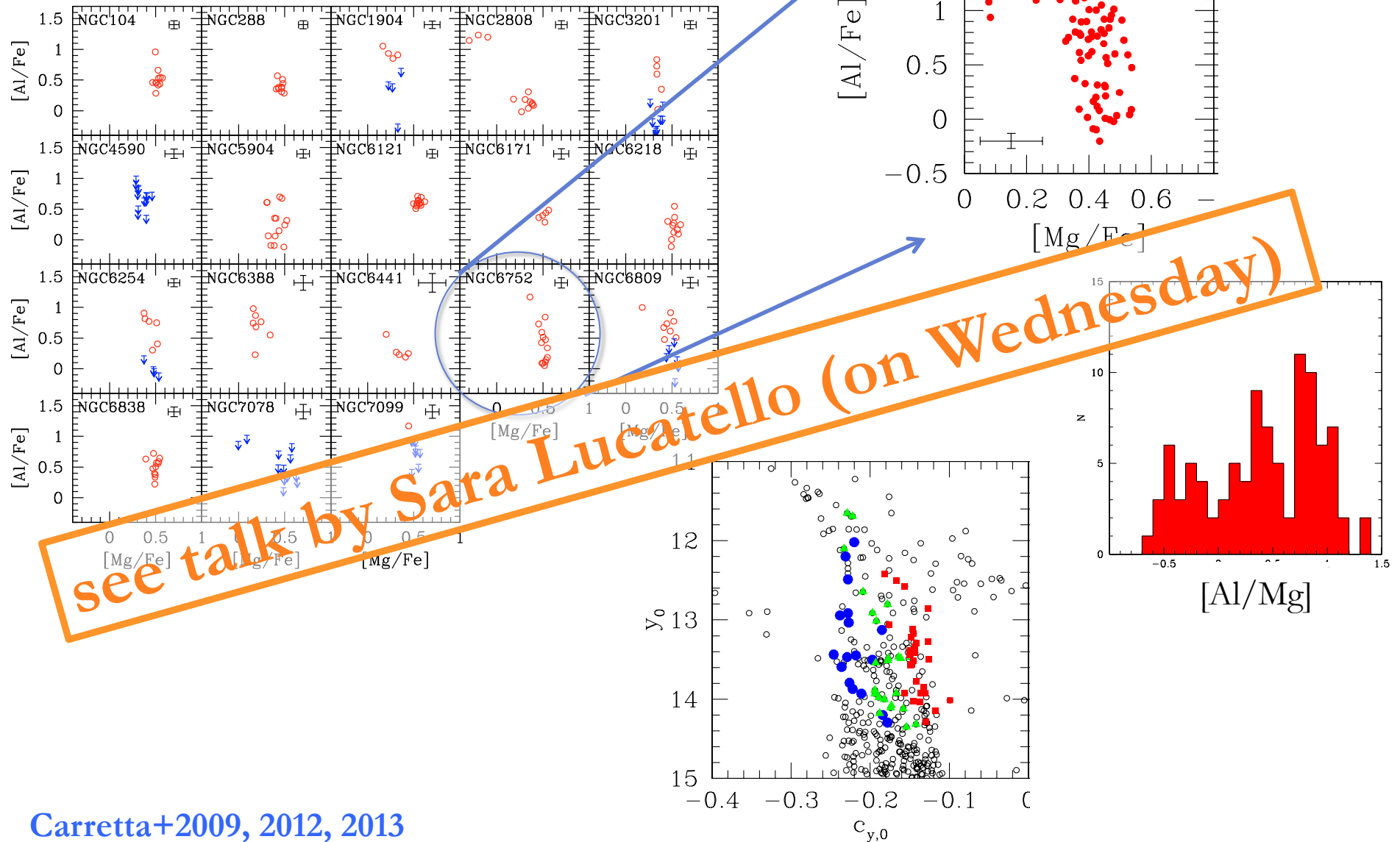
GCs: Na & O in RGB stars



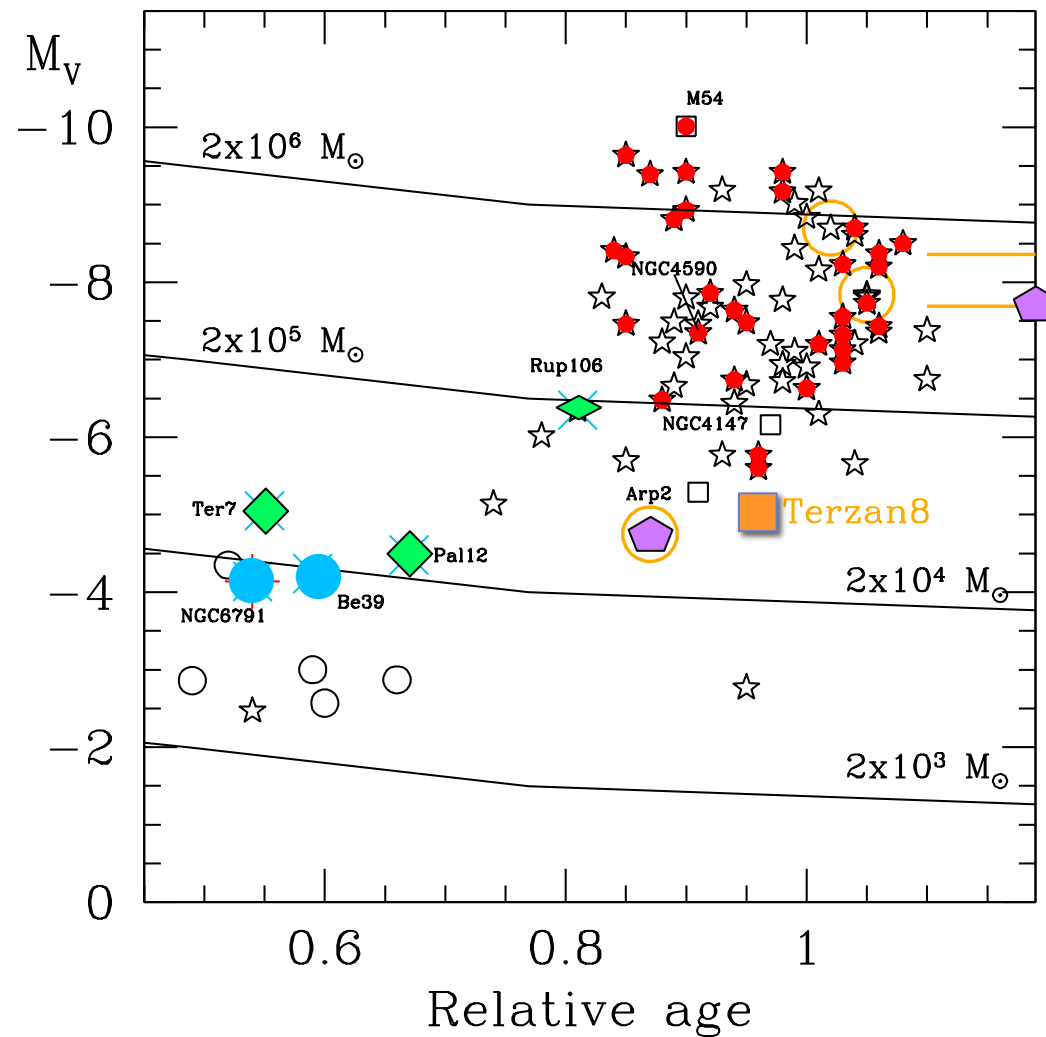
GCs: Na & O in RGB stars



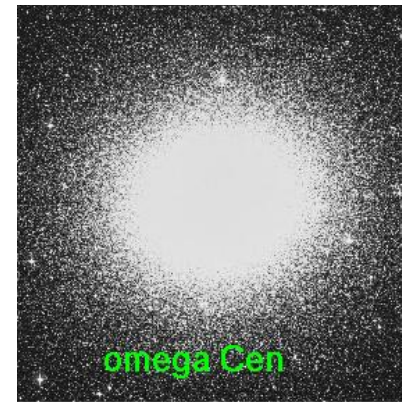
GCs: Mg & Al



All creatures great and small. I. GCs

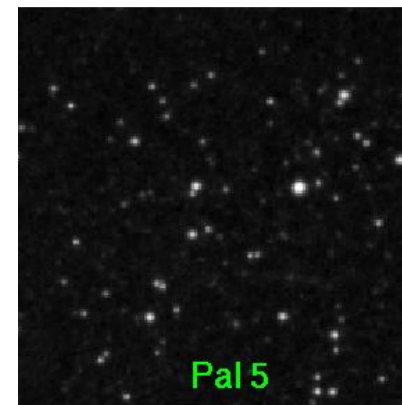


GCs with Na-O anticorrelation



omega Cen

some 10^6
mass in $M_{\odot}$

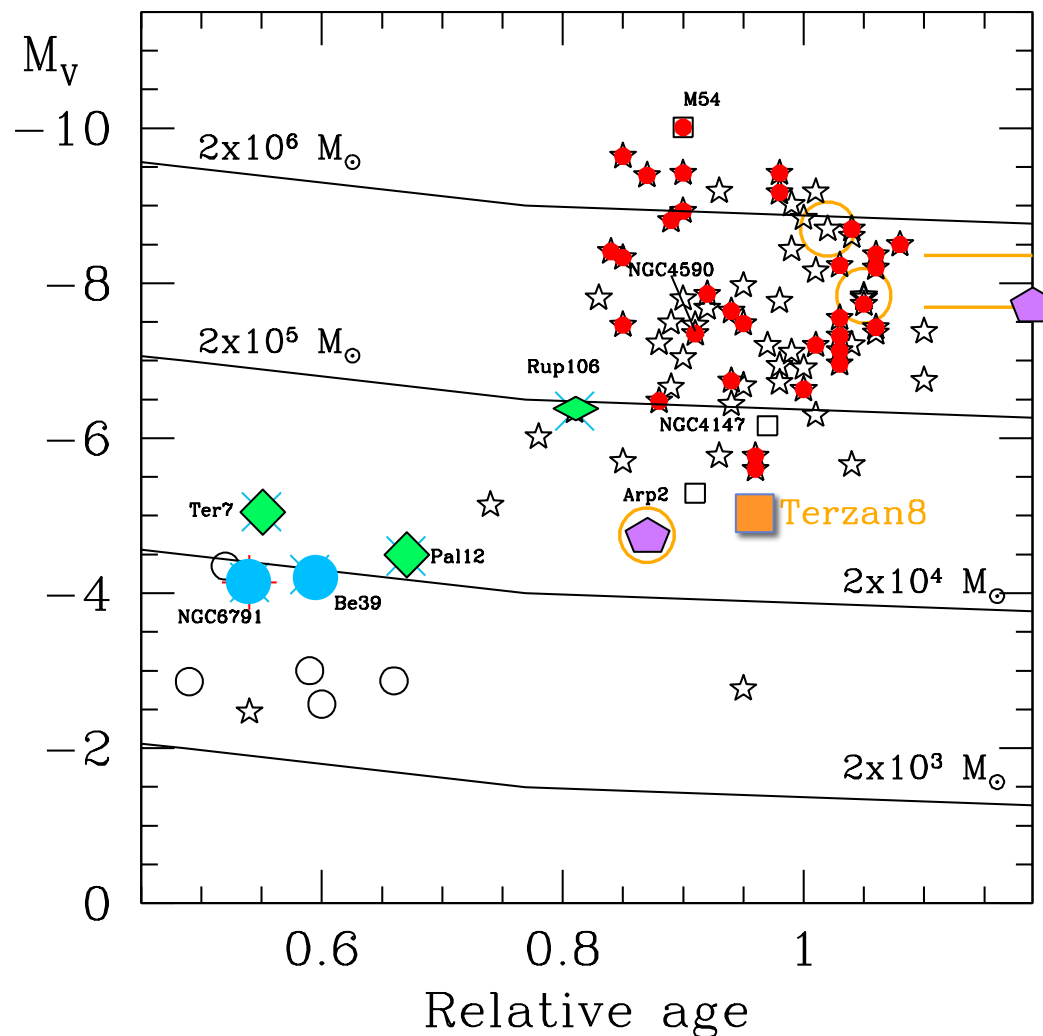


Pal 5

some 10^4

Carretta+2010 etc

All creatures great and small. I. GCs



◆ Ter 7, Pal 12 : no?

◆ Rup 106 : no

■ Terzan 8 : yes?

● Be39, NGC 6791 : no

◆ NGC 6535, NGC 6139 : ??

GCs with Na-O anticorrelation

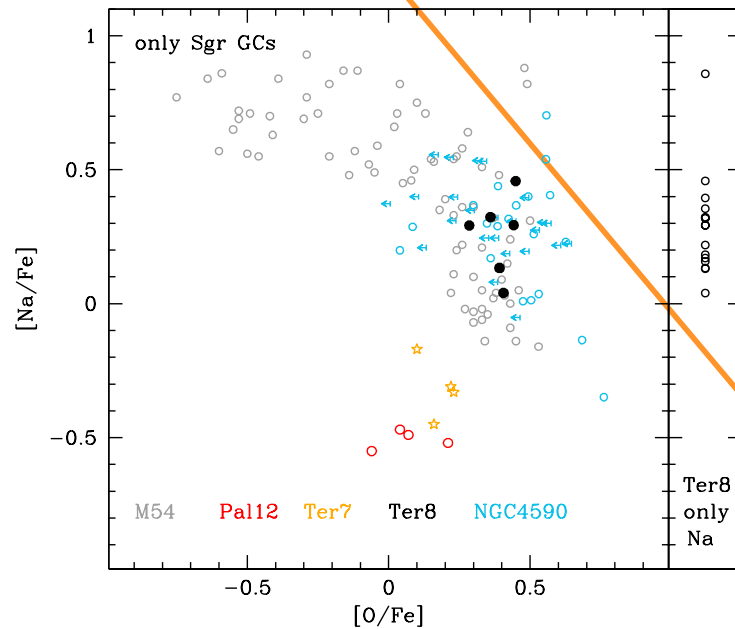
Ter7 : Tautvaisiene+, Sbordone+

Pal12: Cohen

Rup106 : Villanova+

All creatures great and small. I. GCs

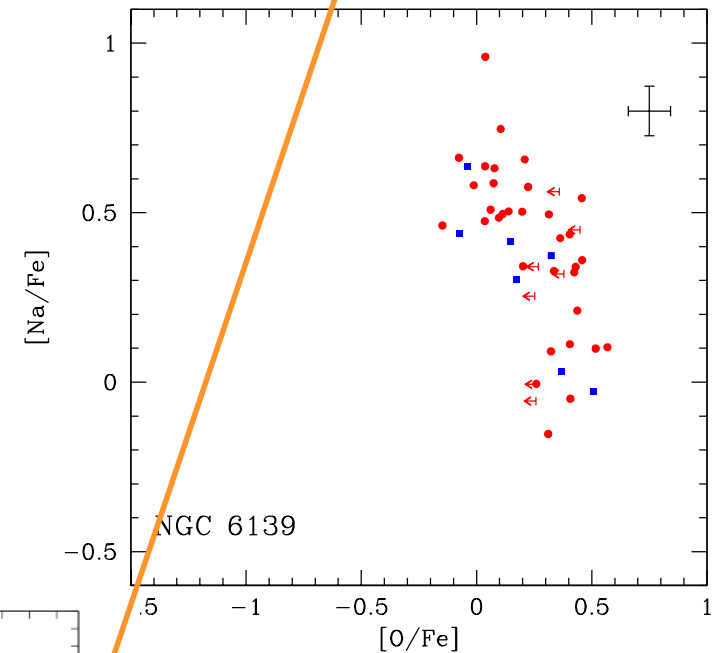
Terzan 8



FG dominates

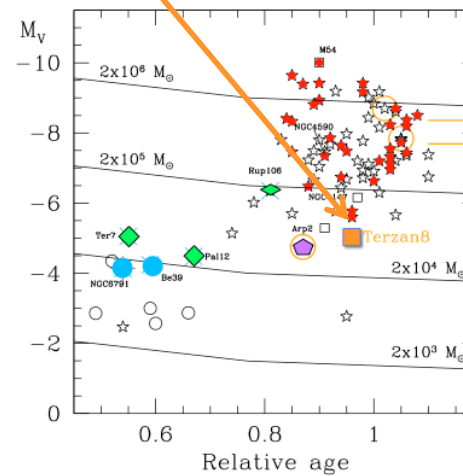
Carretta+2014

NGC 6139

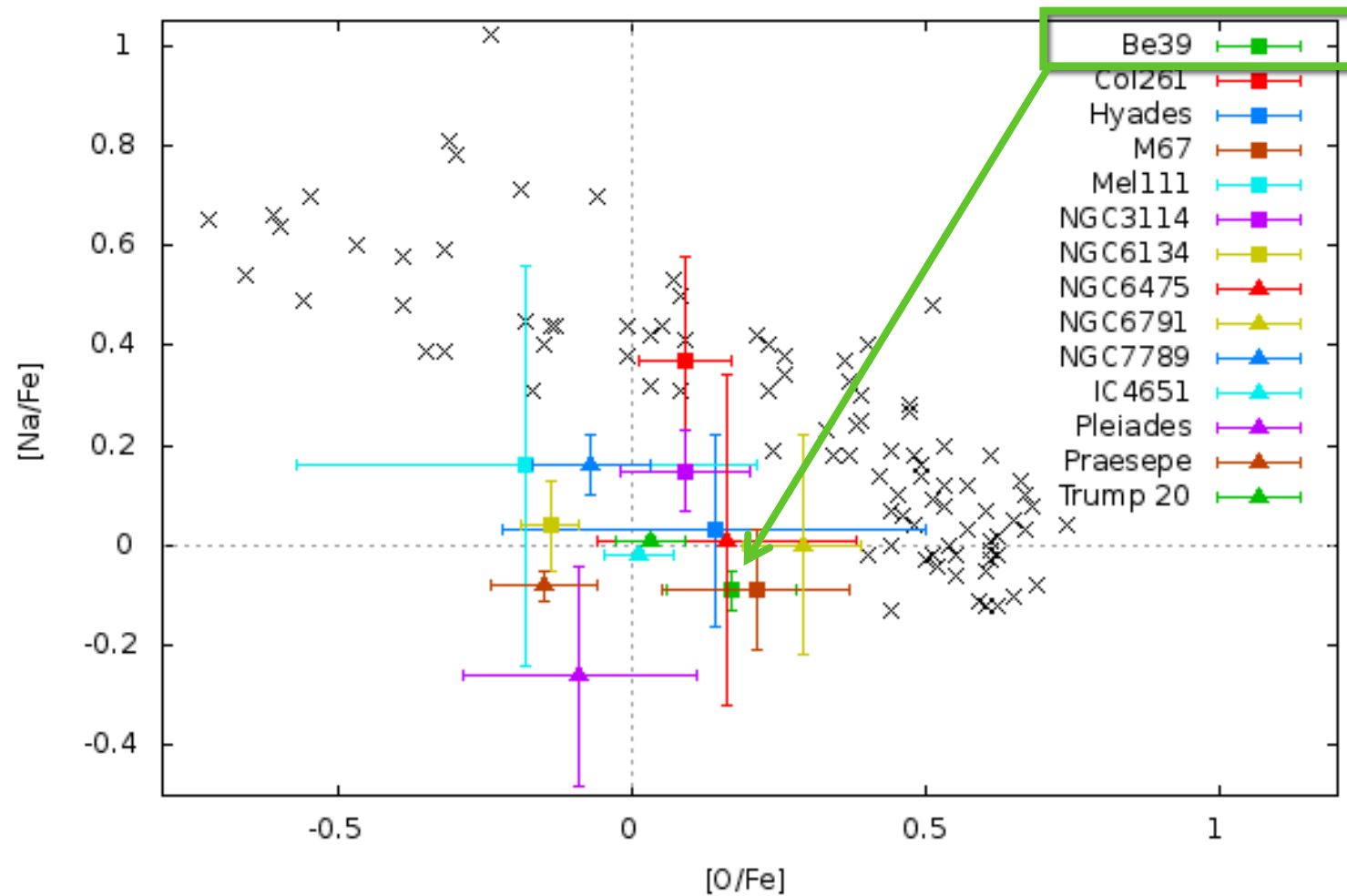


work in progress
“normal” Na-O
SG & FG

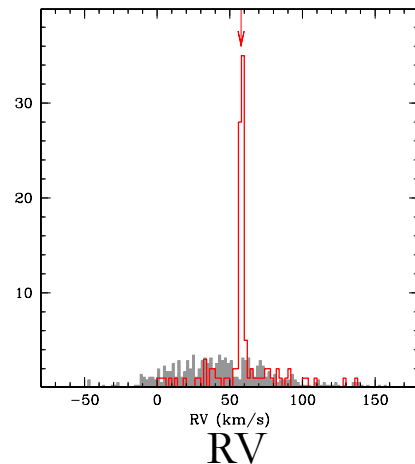
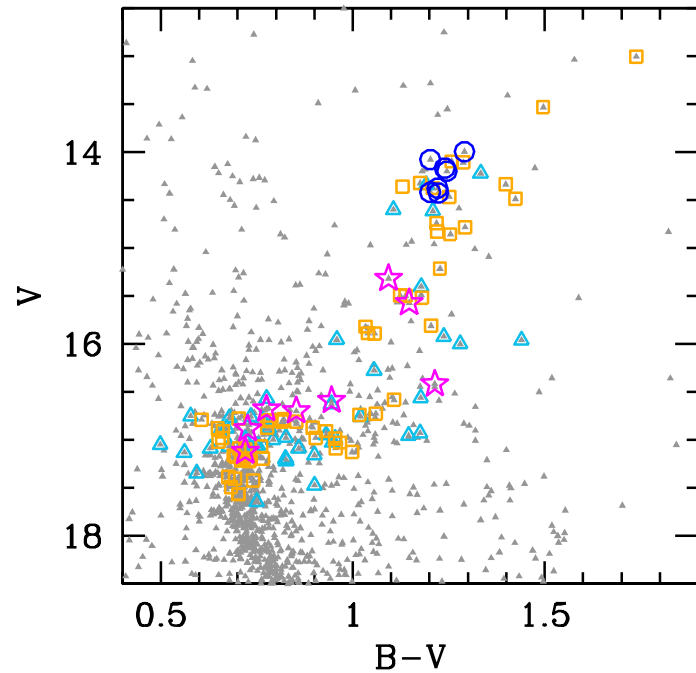
Bragaglia+, in prep.



All creatures great and small. II. OCs



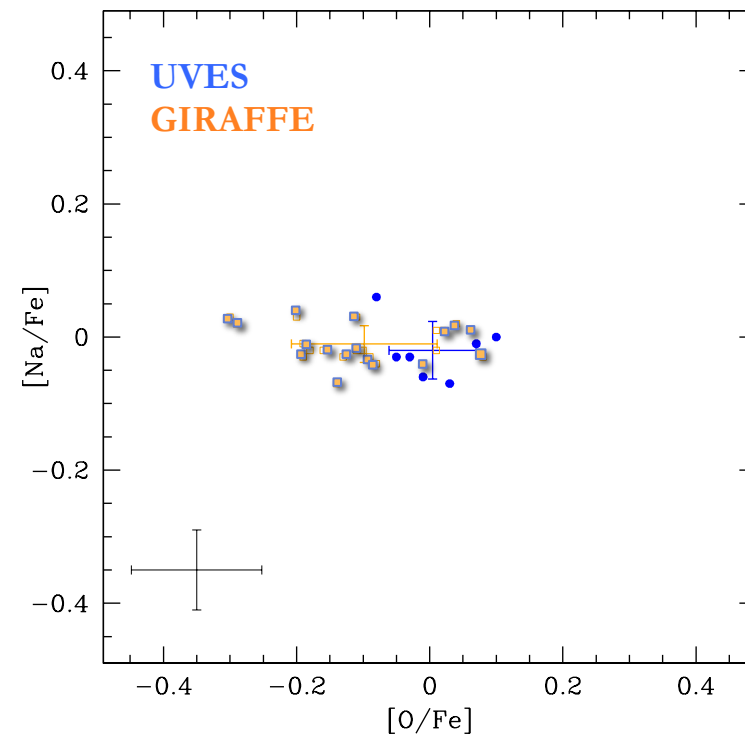
All creatures great and small. II. OCs



Berkeley 39:

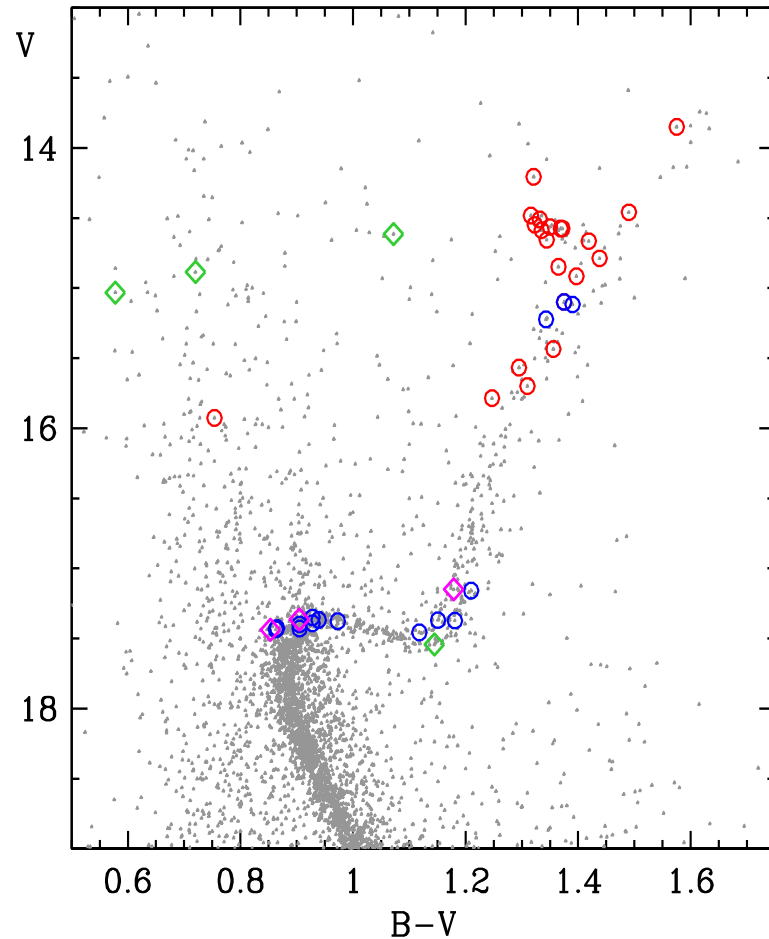
$M_V = -4.28$; age = 6 Gyr

$[Fe/H] = -0.2$



Bragaglia+2012

All creatures great and small. II. OCs



NGC 6791:

$M_V = -4.14$; age = 8 Gyr

$[Fe/H] = +0.4$

Hydra@WIYN

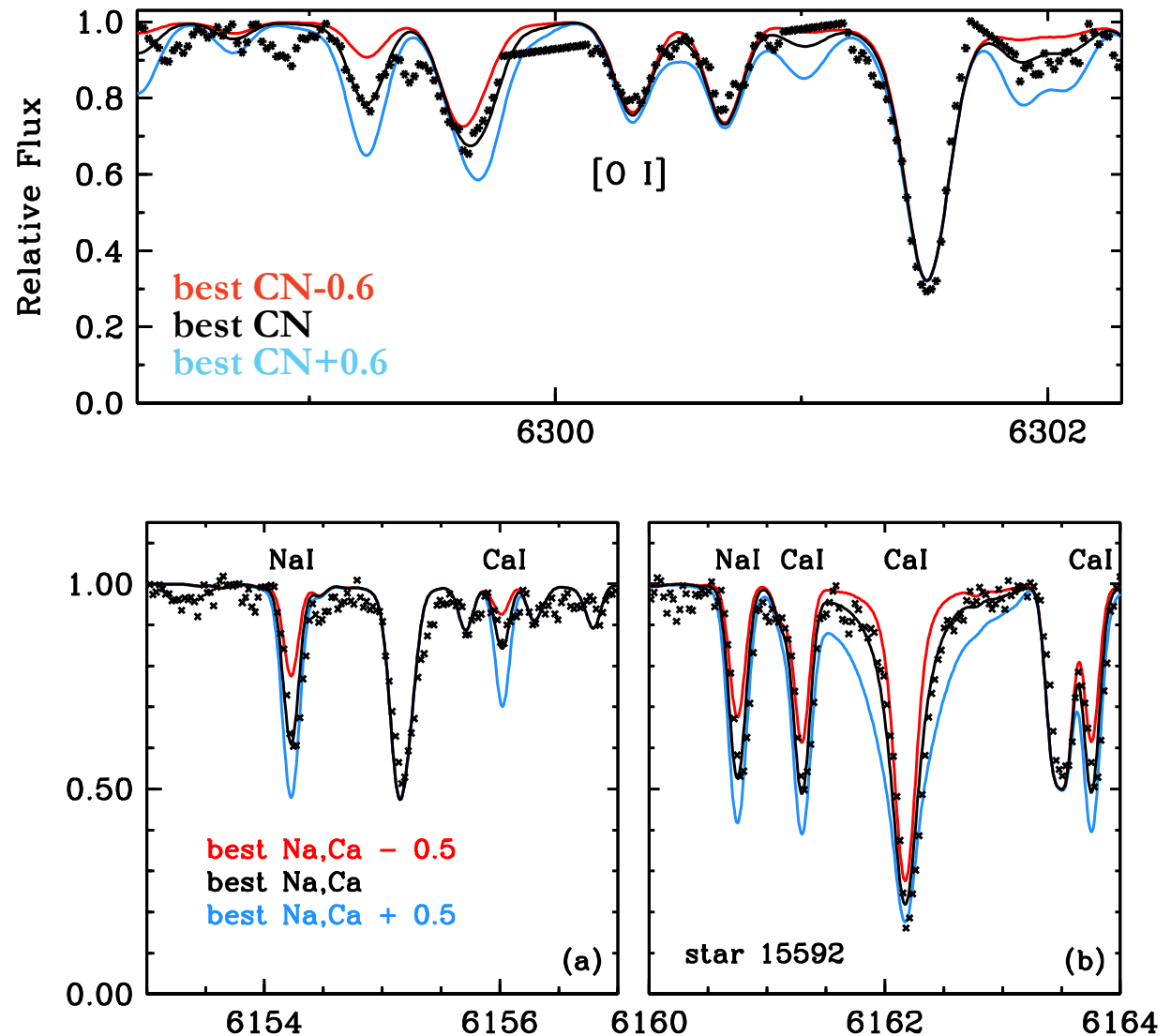
HIRES@Keck

NM (RV) ; NM (met)

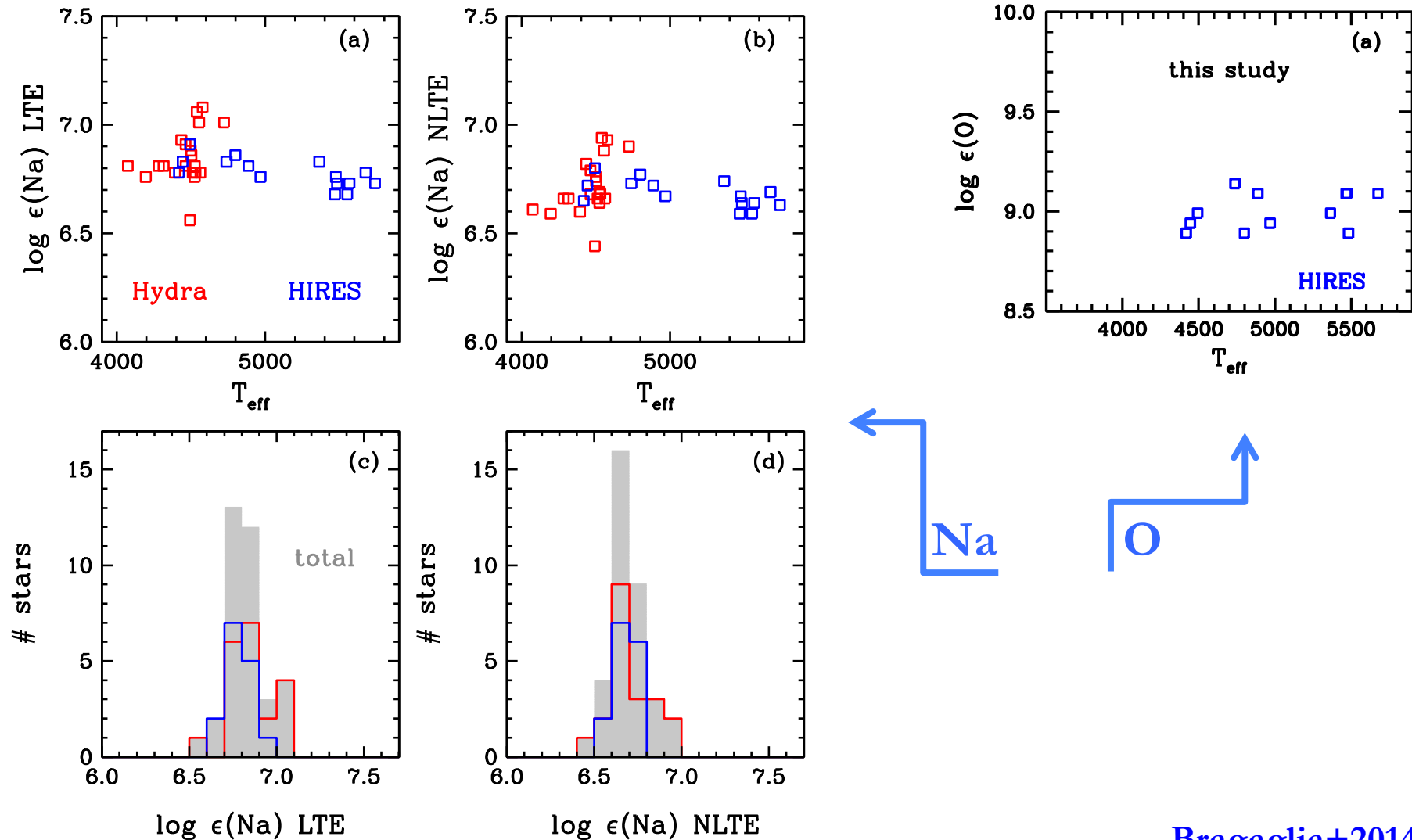
Bragaglia, Sneden, Gratton et al. 2014

All creatures great and small. II. OCs

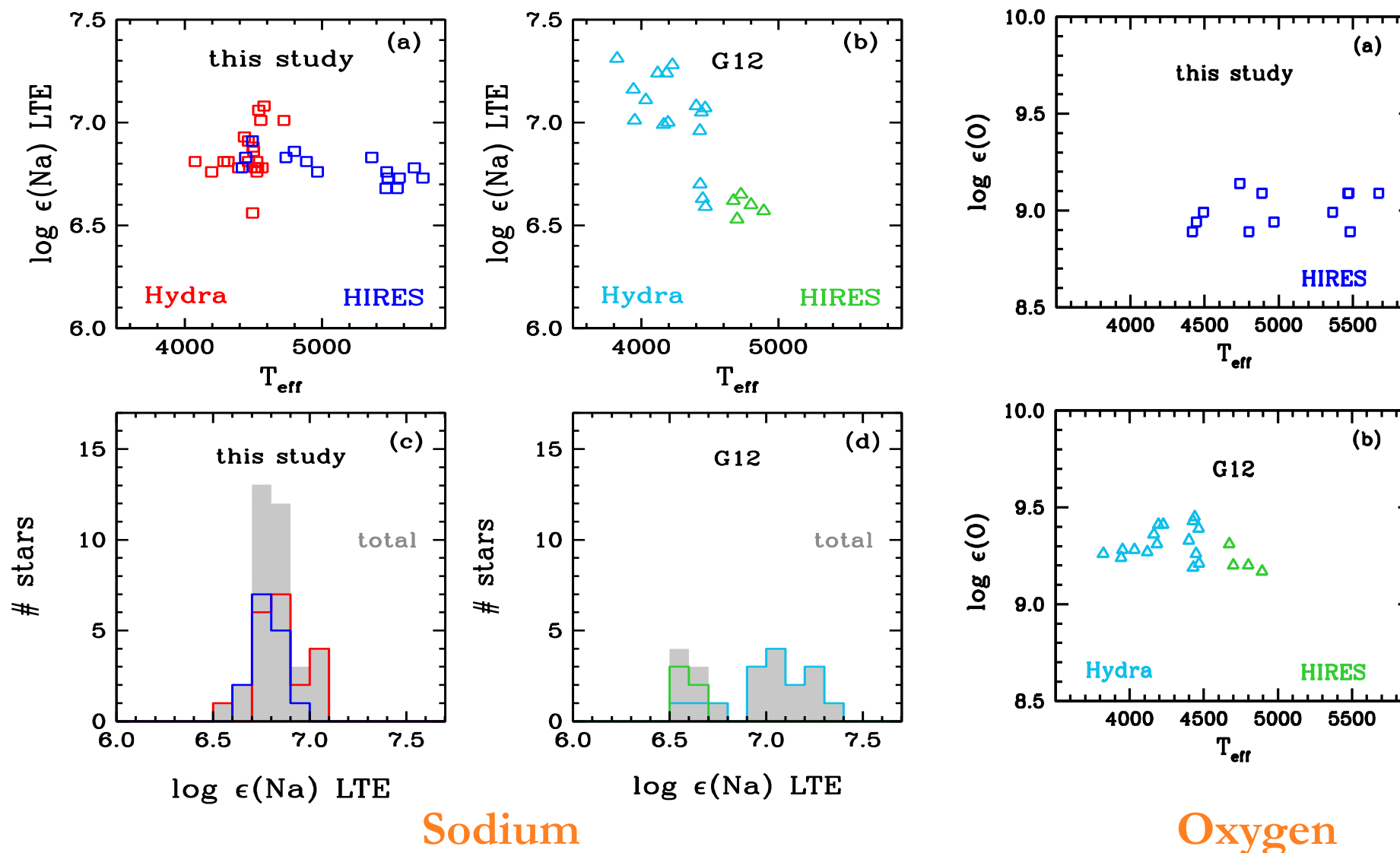
NGC 6791



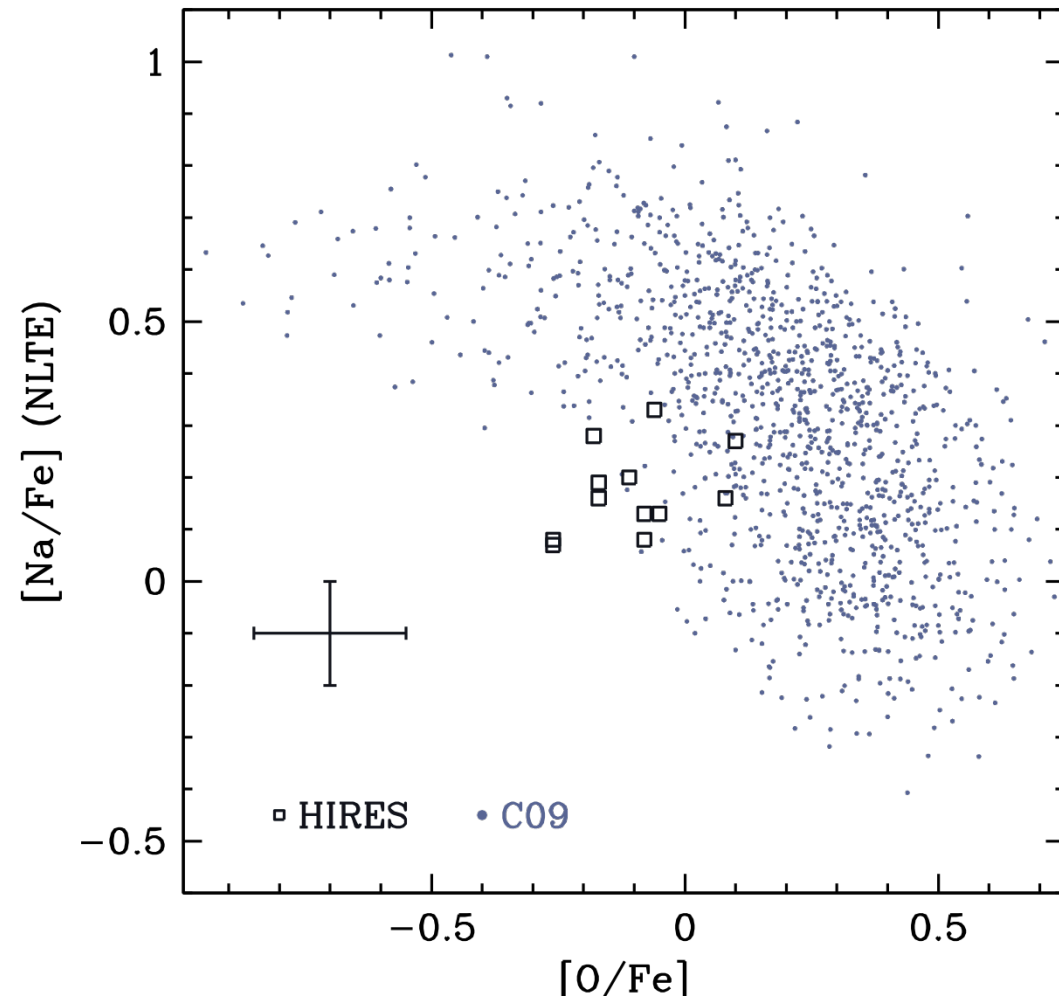
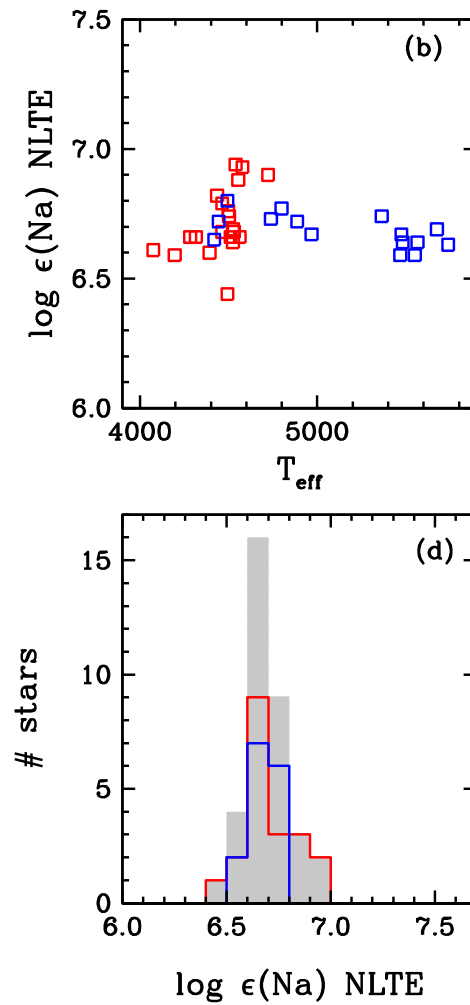
All creatures great and small. II. OCs



All creatures great and small. II. OCs



All creatures great and small. II. OCs



Results & legacy value

- clusters are halo and disk (and bulge) tracers
- constraints for stellar models
- cover both young & old, metal-poor & rich populations
- combine photometry, spectroscopy & models

... wait for Gaia-ESO, APOGEE, etc
and - of course - Gaia ...

IAU Symposium 317 at the 2015 IAU GA

The screenshot shows the IAU website with a dark header featuring the IAU logo and the text "INTERNATIONAL ASTRONOMICAL UNION". Below the header is a navigation bar with links: Home | About IAU | Member Directory | Site Map | Contact Us | Login. A secondary navigation bar contains dropdown menus for News, Science, Publications, Administration, Education, IAU for the Public, Astronomy for Development, and International Year of Light. The main content area has a breadcrumb trail: Home / Science / Scientific Meetings / Future IAU Meetings / Symposia » The General Assembly of Galaxy Halos: Structure, Origin and Evolution. The title "IAU Symposia" is followed by "IAUS 317: The General Assembly of Galaxy Halos: Structure, Origin and Evolution". A table lists event details: Start date/time (August 3, 2015), End date/time (August 7, 2015), Place (Honolulu, United States), and Contact (Angela Bragaglia, angela.bragaglia@oabo.inaf.it). On the right, there is a search bar, social media links (Facebook Like, Share, Tweet), and a section for "Follow the IAU on social media" with Facebook and Twitter icons. At the bottom right is a logo for the "XXIX GENERAL ASSEMBLY Hawaii" featuring the IAU logo, a telescope, and a flower.

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Home / Science / Scientific Meetings / Future IAU Meetings / Symposia » The General Assembly of Galaxy Halos: Structure, Origin and Evolution

IAU Symposia

IAUS 317: The General Assembly of Galaxy Halos: Structure, Origin and Evolution

Start date/time
August 3, 2015
End date/time
August 7, 2015
Place
Honolulu, United States
Contact
Angela Bragaglia angela.bragaglia@oabo.inaf.it

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IAU General Assembly
Honolulu, 3-14 August 2015

XXIX GENERAL ASSEMBLY
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<http://www.iau.org/science/meetings/future/symposia/1124/>
http://www.eso.org/~marnabol/IAU317_index.html