Not only SPA

➢ FIES@NOT & UVES@VLT : OSTTA
  ➜ few giant stars, many clusters

➢ PEPSI @LBT : NGC 2099/M37
  ➜ spread in metallicity?

➢ FLAMES@VLT : NGC 2509
  ➜ no eMSTO, high Vrot
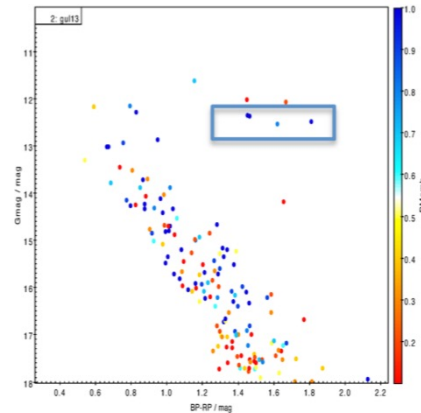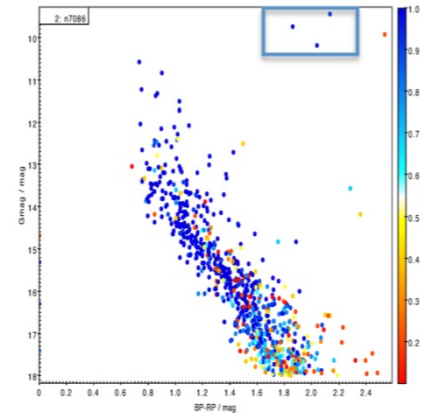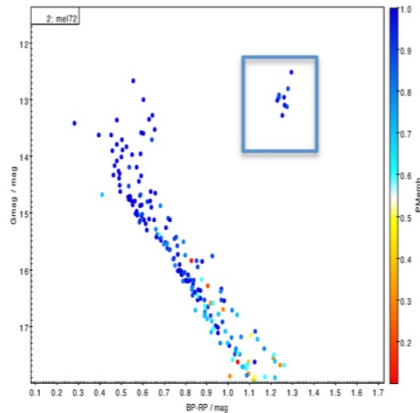
1) OSTTA=One Star to Tag Them All

OSTTA=One Star to Tag Them All

NOT : "One Star to Tag Them All: a snapshot survey of open clusters chemistry "

FIES, 8 nights Dec 2018-April 2019

AB, L. Balaguer-Nunez, L. Casamiquela,
G. Catanzaro, X. Fu, E. Carretta, C.
Soubiran, R. Carrera, V. D'Orazi, A.
Frasca, S. Lucatello, L. Magrini, A. Vallenari,
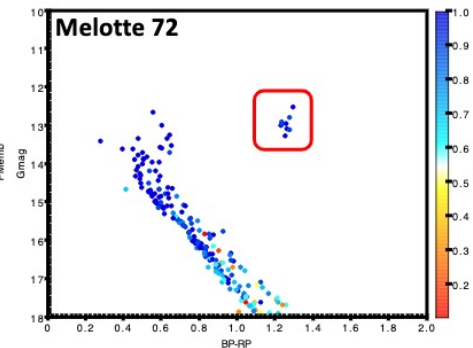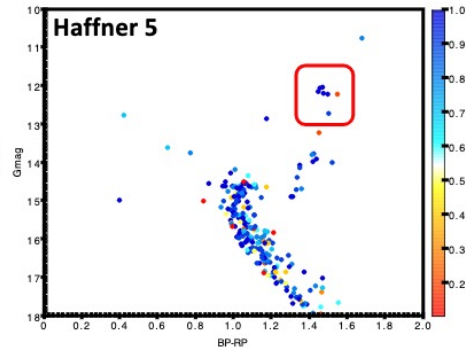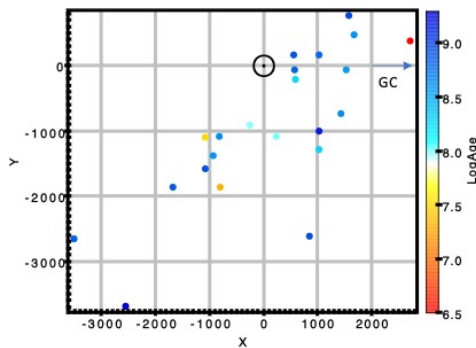*C. Jordi, T. Cantat-Gaudin*

ESO : "Fingerprinting open clusters: a snapshot survey to complement the Gaia results"

UVES any-weather program
P104, 106, 107 (2020-2021) – 50hr each
UVES slit (390+580), R=45000

AB, L. Balaguer-Nunez, G. Casali,
L. Casamiquela, X. Fu, E. Carretta,
C. Soubiran, R. Carrera, V. D'Orazi,
S. Lucatello, L. Magrini, A.
Vallenari. C. Jordi, T. Cantat-Gaudin
(+ M. Baratella)

OSTTA=One Star to Tag Them All

Carrera, Casamiquela, Bragaglia, Carretta, Carbajo-Hijarrubia, Jordi, Alonso-Santiago, Balaguer-Nunez, Bratella, D'Orazi, Lucatello, Soubiran "One Star to Tag Them All (OSTTA) I. Radial velocities and chemical abundances for 20 poorly studied open Clusters", 2022, A&A 663, A148

20 clusters, 41 stars chosen on GDR2
(8 stars excluded as NM or bin)
Age 30 Myr-1.9 Gyr (median 350 Myr)

FIES @ NOT (2.5m tel, Canary Islands)
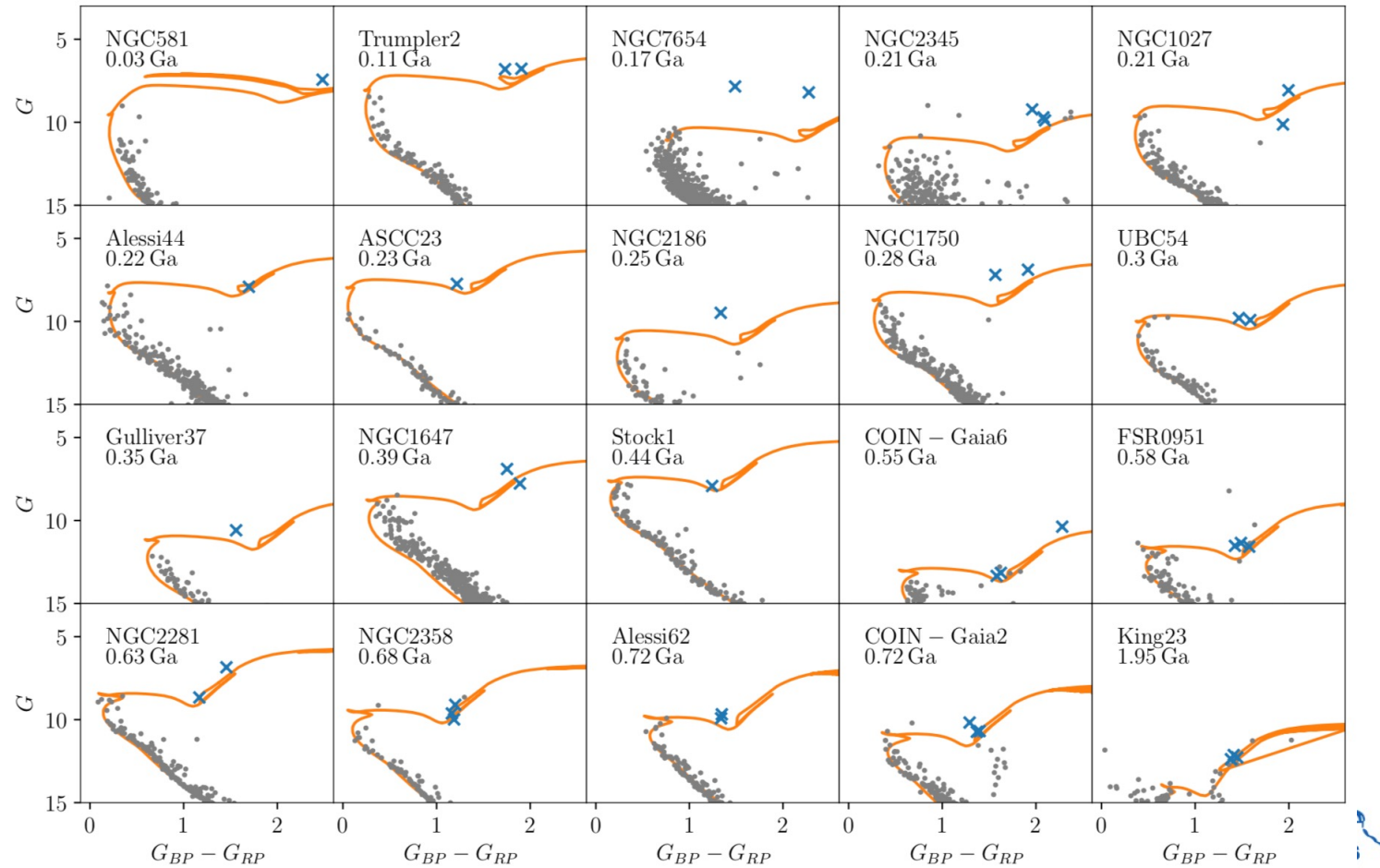2 fibres (star+sky, sky+WLC)
R=25000,46000,**67000**

OSTTA=One Star to Tag Them All

Carrera, Casamiquela, Bragaglia, Carretta, Carbajo-Hijarrubia, Jordi, Alonso-Santiago, Balaguer-Nunez, Bratella, D'Orazi, Lucatello, Soubiran "One Star to Tag Them All (OSTTA) I. Radial velocities and chemical abundances for 20 poorly studied open Clusters", 2022, A&A 663, A148

Teff, logg, metallicity for 32 stars: synth Spectrum, LTE, SPECTRUM in iSpec, MARCS model atm, Gaia-ESO linelist
→ "OCCASO style"
Na, Mg, Al, Si, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Y, Ba, Ce, Nd for 28 well behaved stars
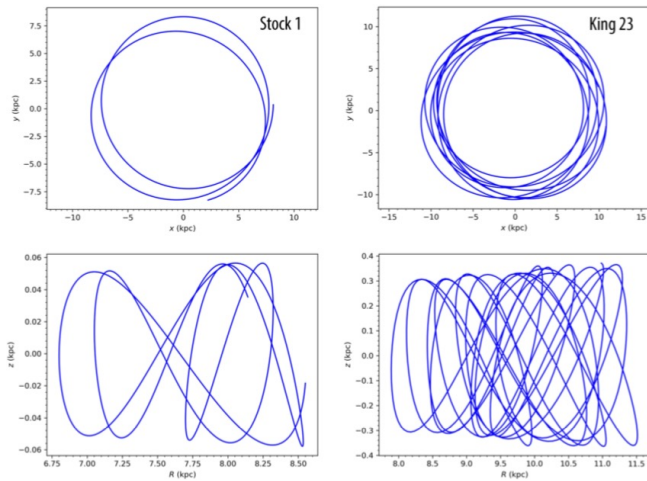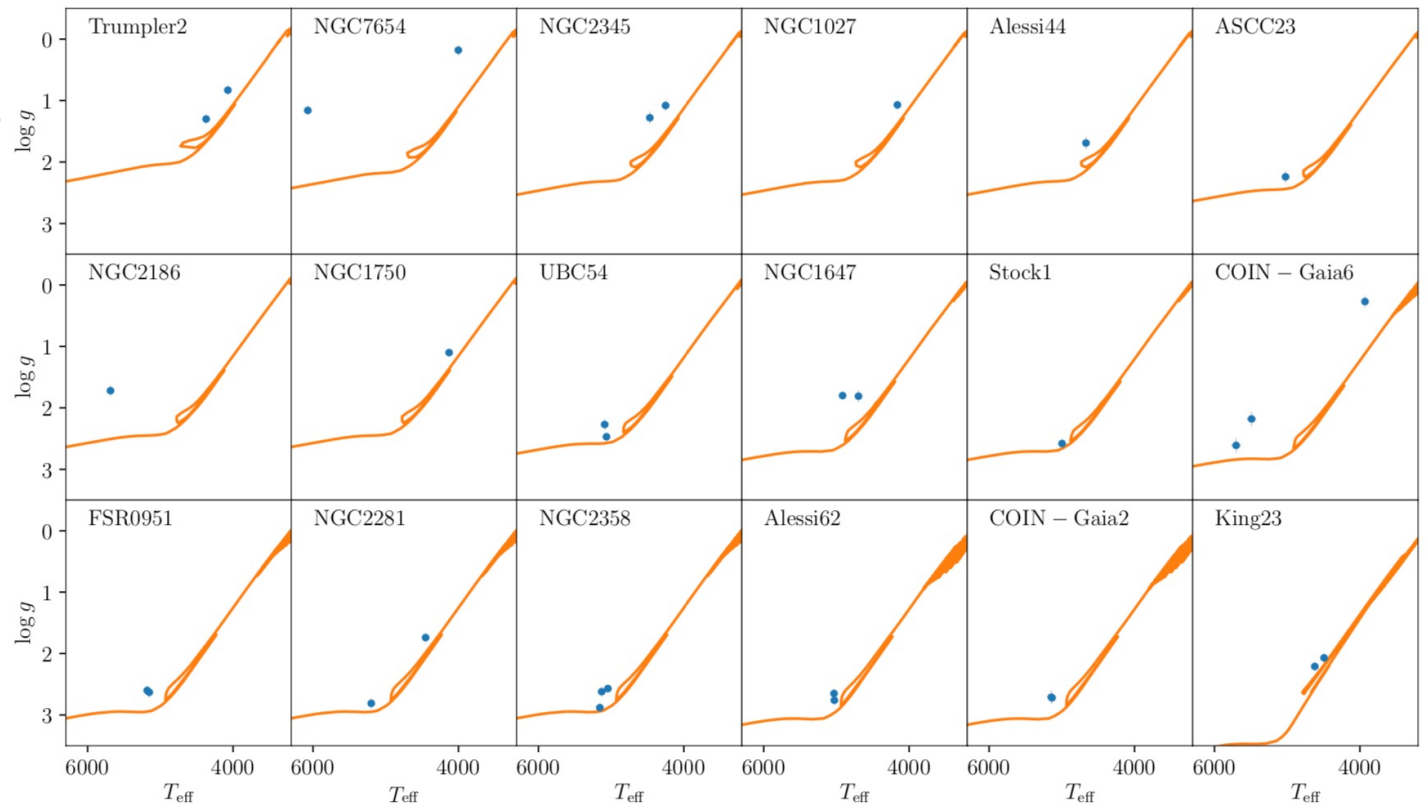
OSTTA=One Star to Tag Them All

32 OCs, 105 stars (min=1, max=5, generally 4)

Stars selected on the RED CLUMP (to our best understanding of the Gaia CMD)
➔ There are no young clusters, only intermediate-age and old

Martina Baratella already analysed a large chunk, using q2 etc, under supervision of Valentina DOrazi
My fault if nothing is out yet

INAF
ISTITUTO NAZIONALE
DI ASTROFISICA
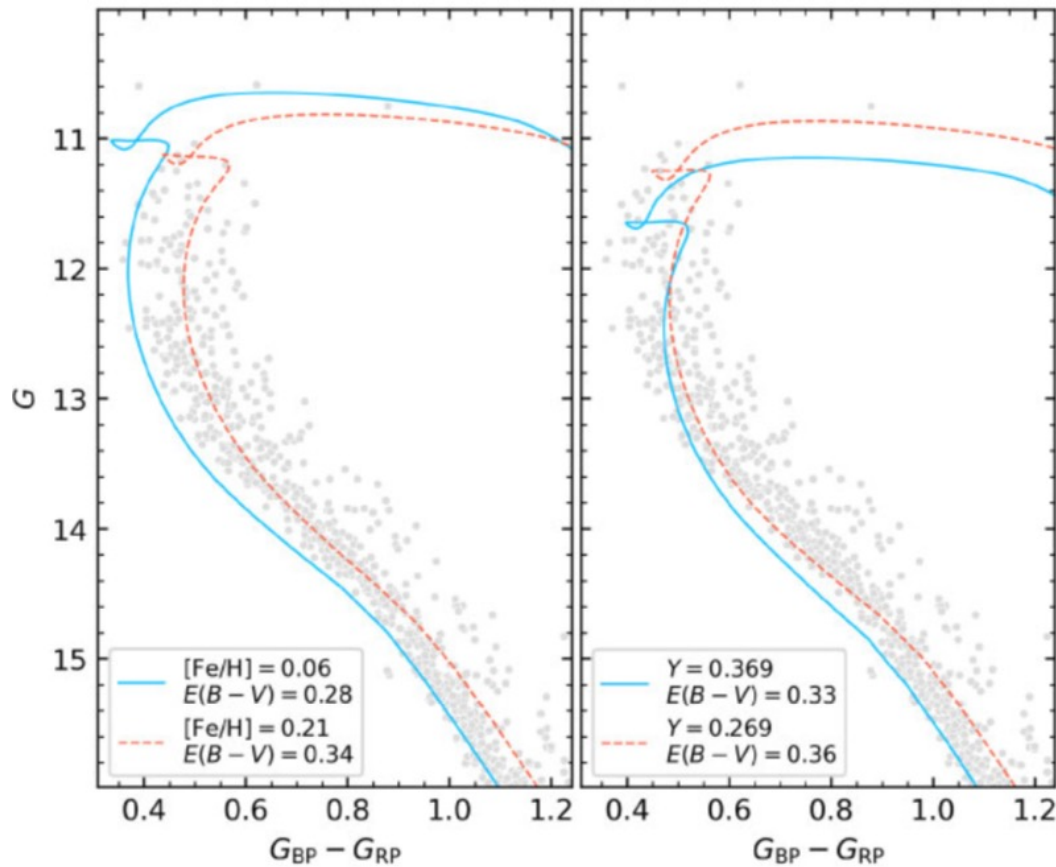
OAS
BOLOGNA

OSTTA=One Star to Tag Them All
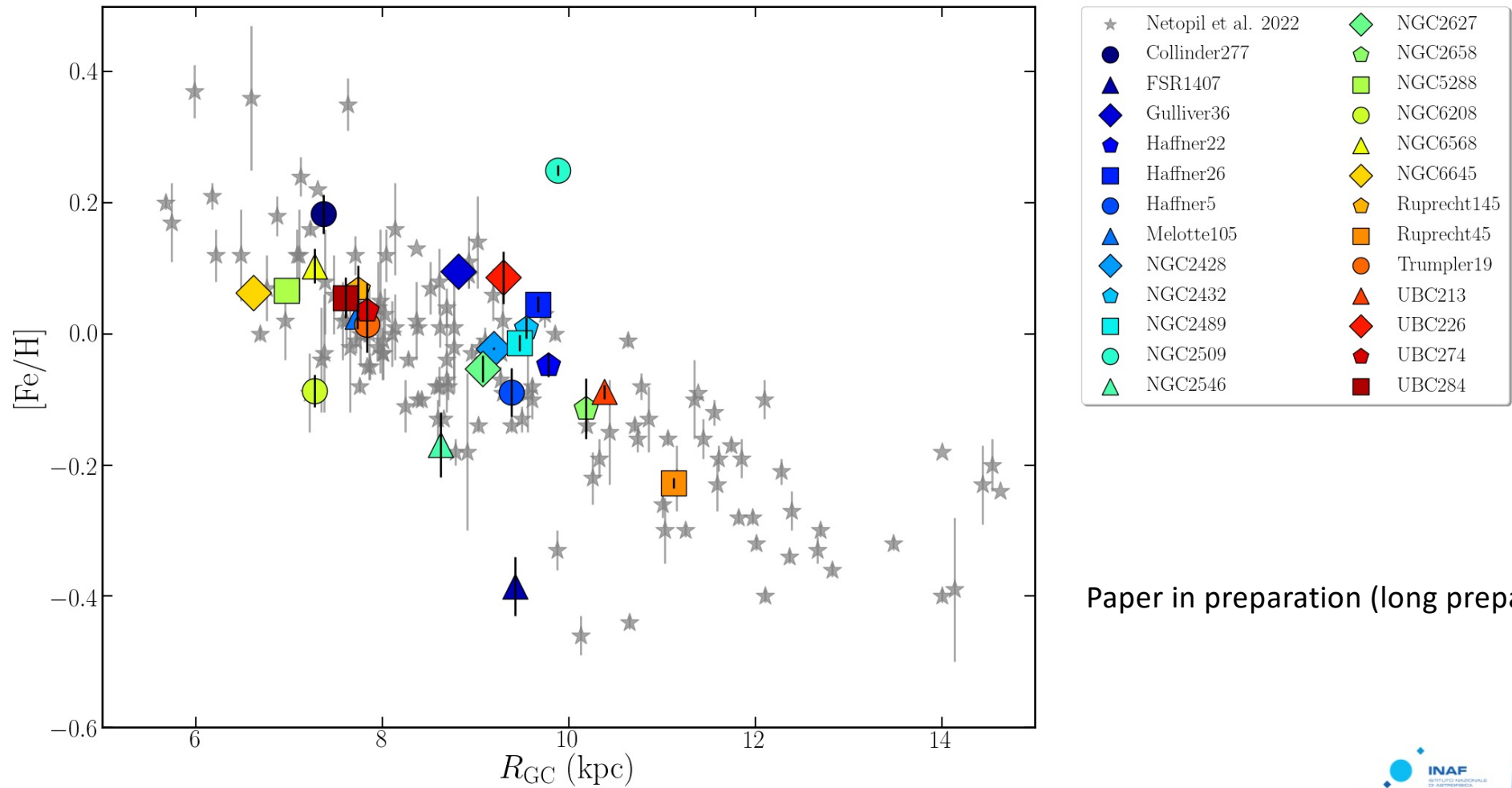
Paper in preparation (long preparation…)

2) NGC 2099/M37 – PEPSI @LBT

NGC 2099/M37 – PEPSI @LBT

Griggio, Salaris, Cassisi, Pietrinferni , Bedin "Signature of a chemical spread in the open cluster M37" 2022, MNRAS 516, 3631

The cluster has an eMSTO, seen in Gaia and Sloan data

Rotation and/or differential reddening and/or binaries cannot explain it.

Δ[Fe/H]=0.15 or ΔY=0.1 (+some diff. reddening) can !

"To discriminate more reliably between metallicity and helium spread, high-resolution differential abundance determinations of a sizeable sample of cluster stars are then necessary, *because they can confirm or exclude the presence of a metal abundance spread.*
The existing more direct measurements – based on very small samples of targets – do not allow to draw solid conclusions. "
[apparantly they forget OCCASO here]

NGC 2099/M37 – PEPSI @LBT

PEPSI observation modes.

Proposal 2023

AB, Martina Baratella,
Valentina D'Orazi, Sara
Lucatello, Antonella
Vallenari, Nagaraj
Vernekar

Is M37 the first open cluster with a metallicity spread?

LBT binocular, 3.4 h
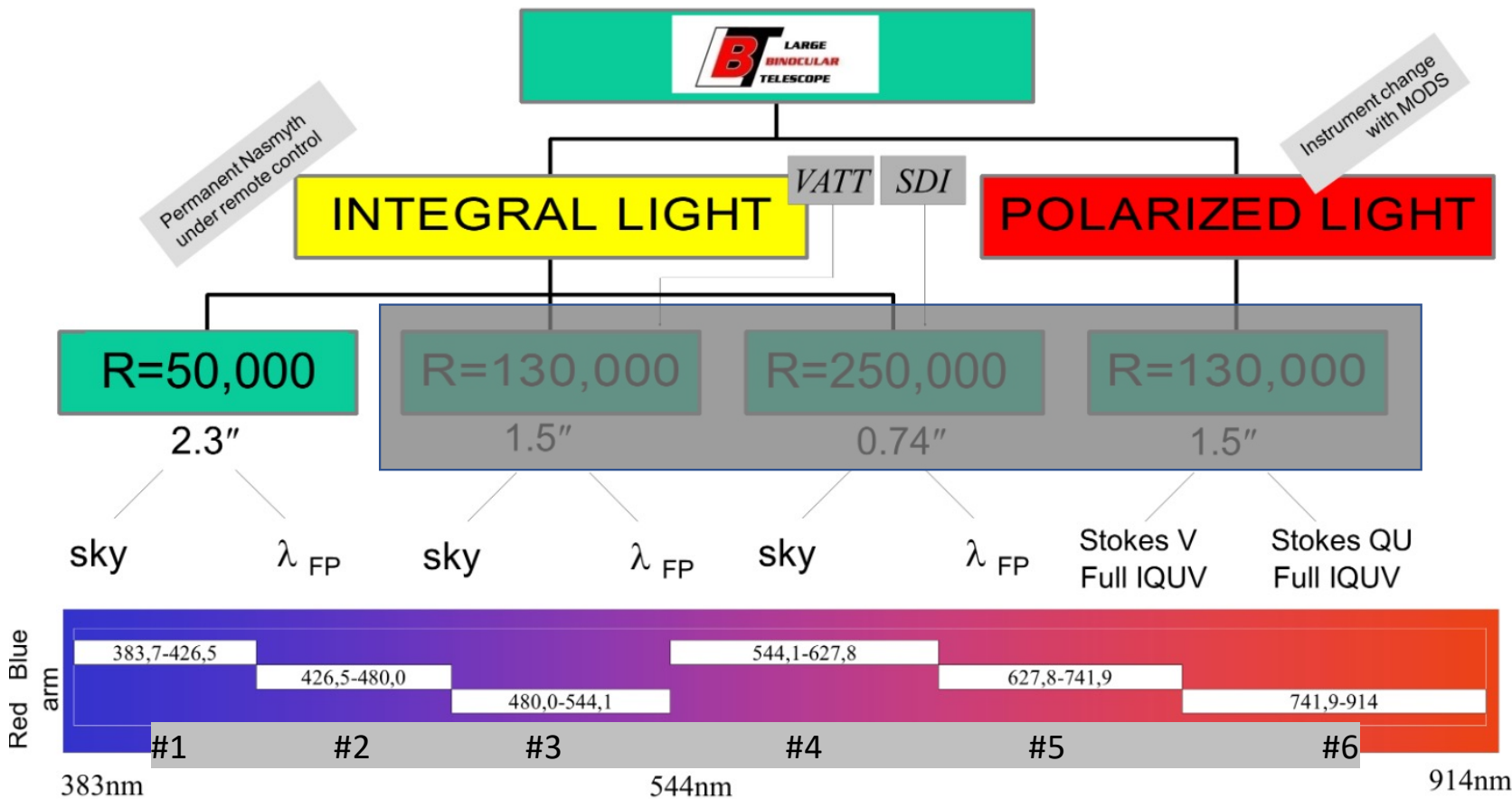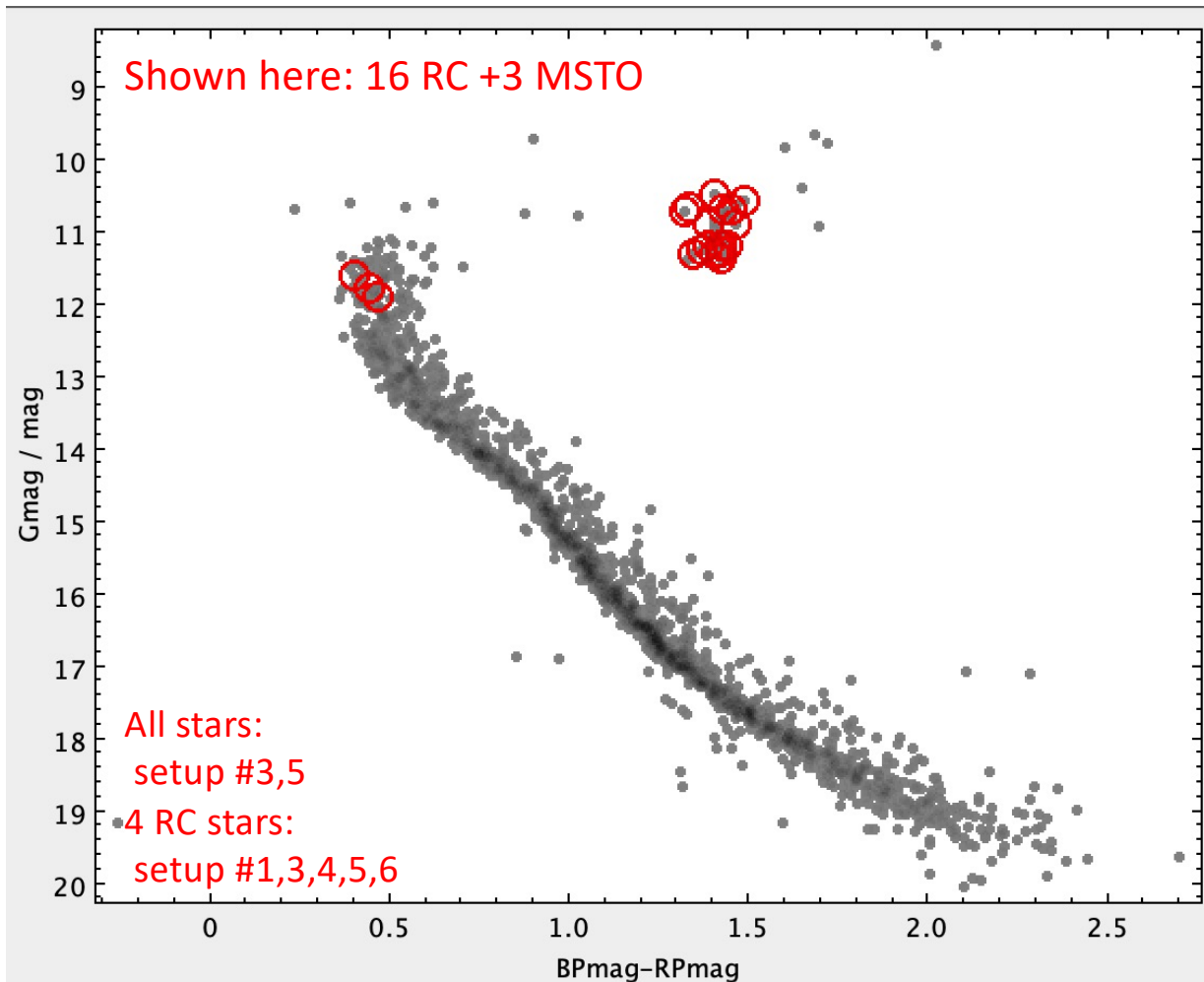R=50000
All stars:
 setup #3,5
4 RC stars:
 setup #1,3,4,5,6

NGC 2099/M37 – PEPSI @LBT

Shown here: 16 RC +3 MSTO

All stars:
 setup #3,5
4 RC stars:
 setup #1,3,4,5,6

Age=400 Myr
Distance=1.4 kpc
Observed with PEPSI in Sep, Oct 2023, Jan 2024:
  22 RC stars (not in OCCASO, of which 4 with 5 setups),
   7 MSTO stars (Vbroad<30 km/s)

LAMOST : R~2000
    80+ stars
    50+ with [Fe/H]
    ave=-0.01 std 0.22 dex
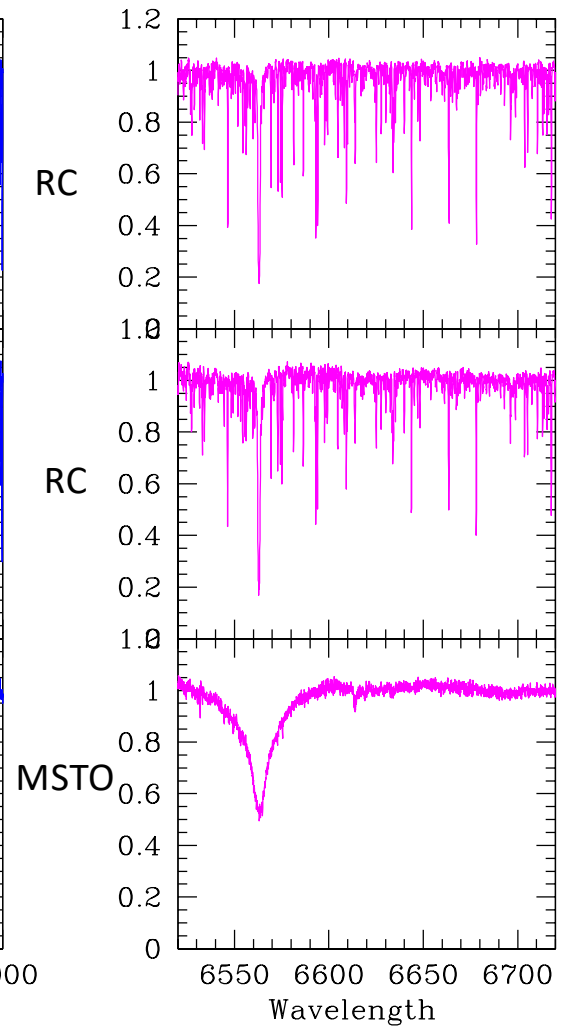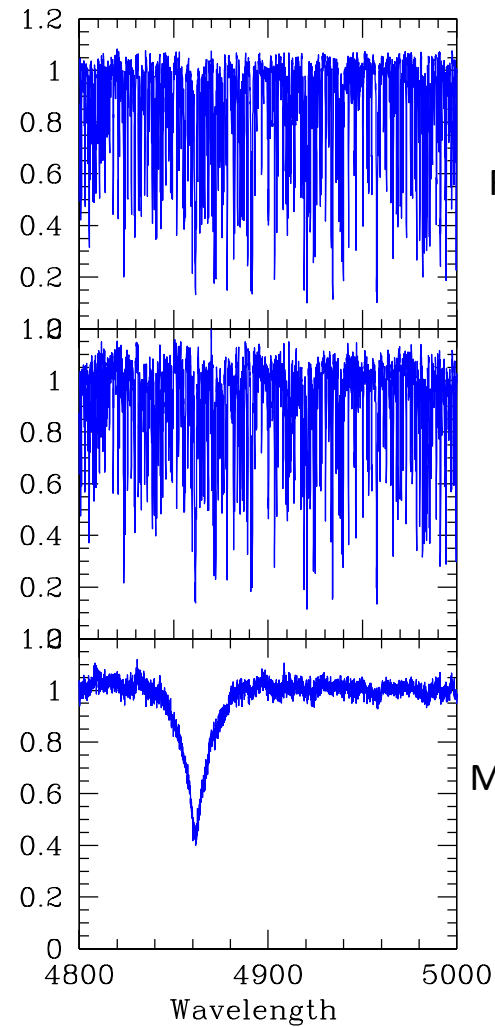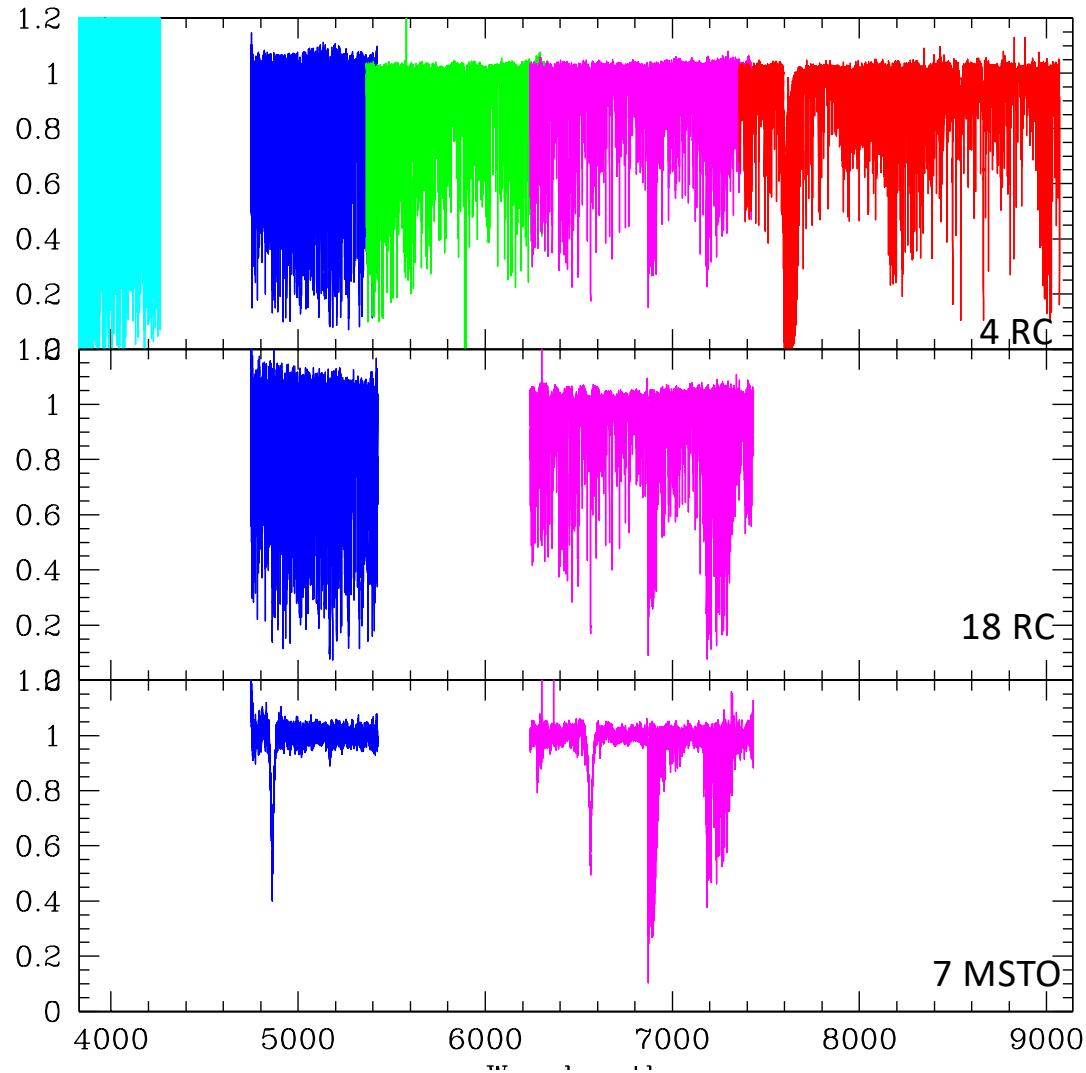   (*Fu, AB, et al. 2022*)

OCCASO : R>65000
    7 RC stars
    ave(GALA)=0.08 ± 0.03
    ave(iSpec)=0.00 ± 0.02
    (*Casamiquela,Carrera, et al. 2017*)

NGC 2099 – PEPSI @LBT

Spectra reduced by Ilya Ilyn @AIP

12

NGC 2099/M37 – PEPSI @LBT

Valentina did a lot of work and tests

1) Analysis using EWs with ARES + q2 or LOTUS (NLTE) does not work for stars for which the two central gratings are missing. Offset in metallicity of -0.1 dex due to lack of Fe lines.

2) A few more stars to be added to the list – e.g. all MSTO stars left out right now.

3) We are planning to synthesise with pySME in NLTE only lines in common between the different setups and see what we get. This is in progress, tests just started.

4) If unsuccessful, we might need to submit a complementary proposal (May 2024)

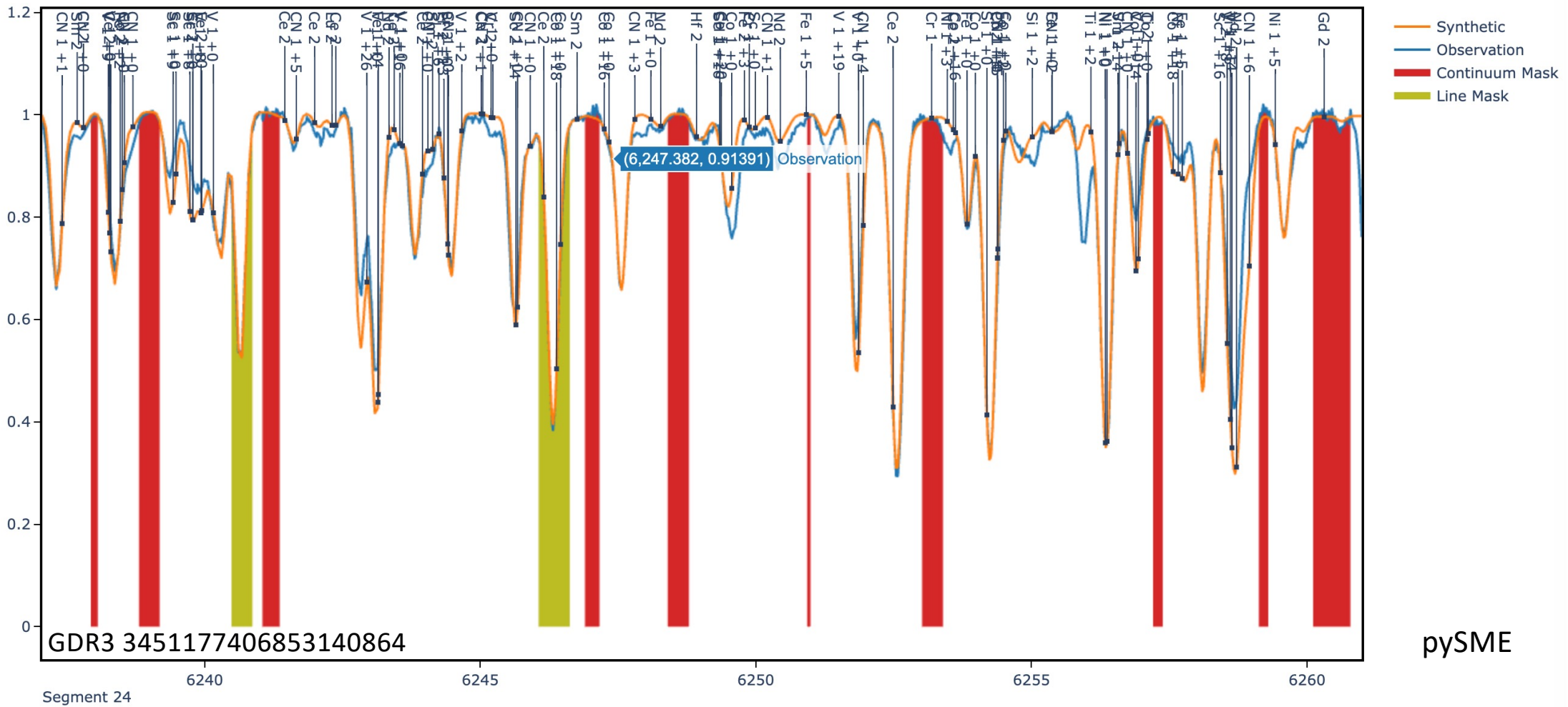# NGC 2099/M37 – PEPSI @LBT

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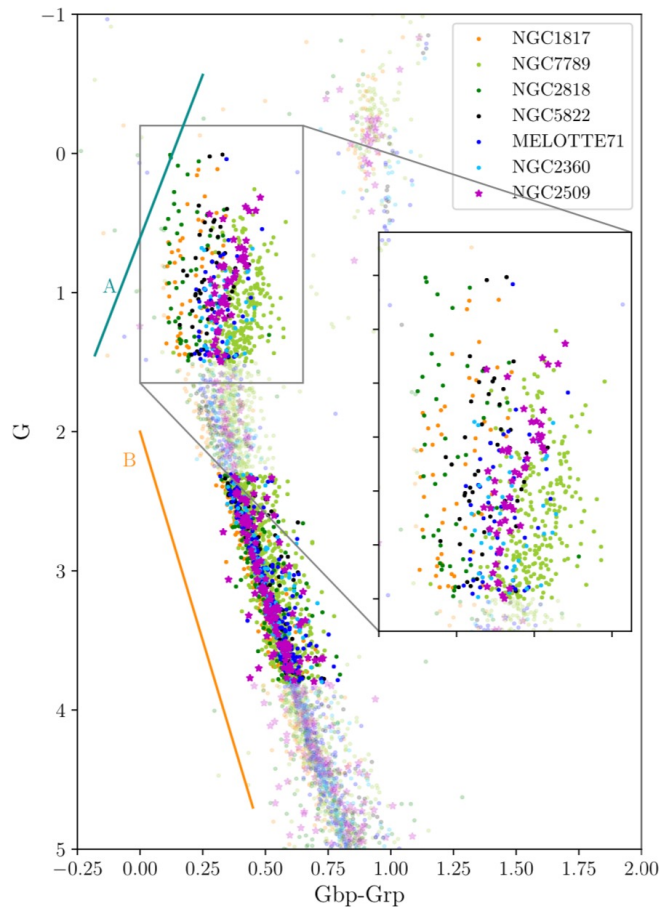
NGC 2099/M37 – PEPSI @LBT

GDR3 3451177406853140864

pySME

Segment 24

3) NGC 2509 – FLAMES@VLT

NGC 2509 – FLAMES@VLT

de Juan Ovelar, Gossage, Kamann, et al. (2020) "Extended main sequence turnoffs in open clusters as seen by Gaia - II. The enigma of NGC 2509", MNRAS, 491, 2129
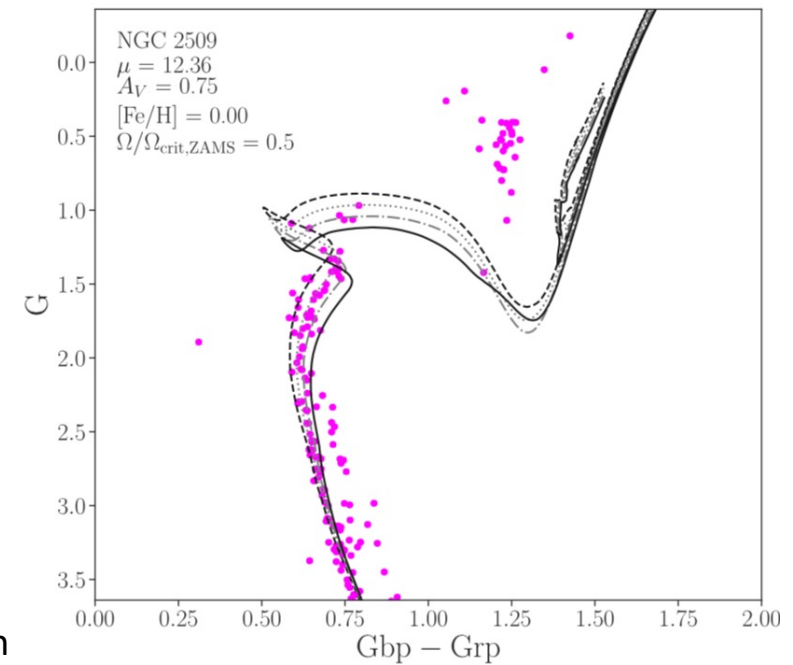

They have 7 OCs (with ages around 900 Myr – they say)

All show eMSTOs – except NGC2509

The cluster CMD can be fit with rotating isochrones better than non-rot., with a best fit with $\Omega = 1/2 \; \Omega$crit

Binaries are about 50%

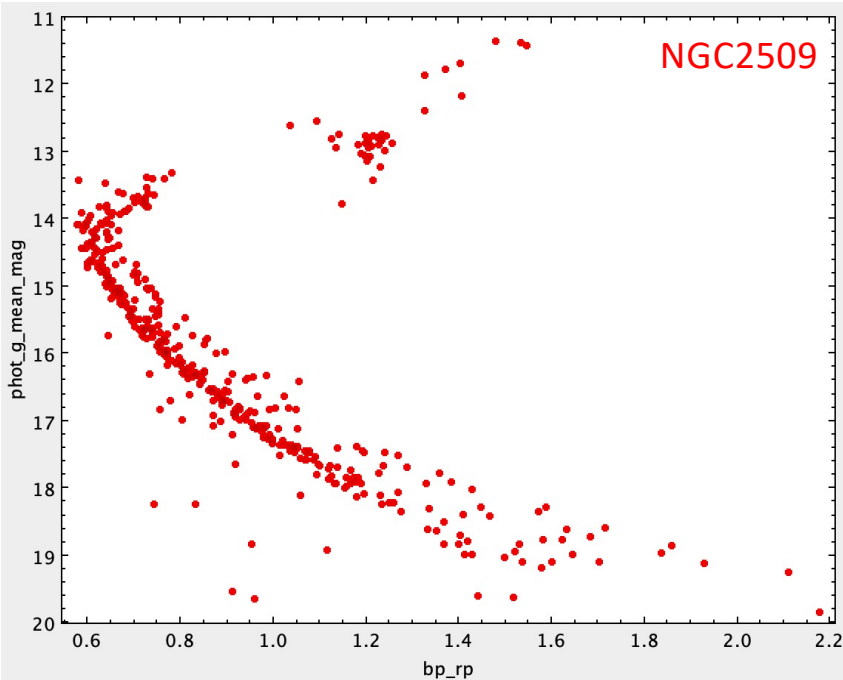➔ The cluster is special and we can learn something on how rotation influences the CMD
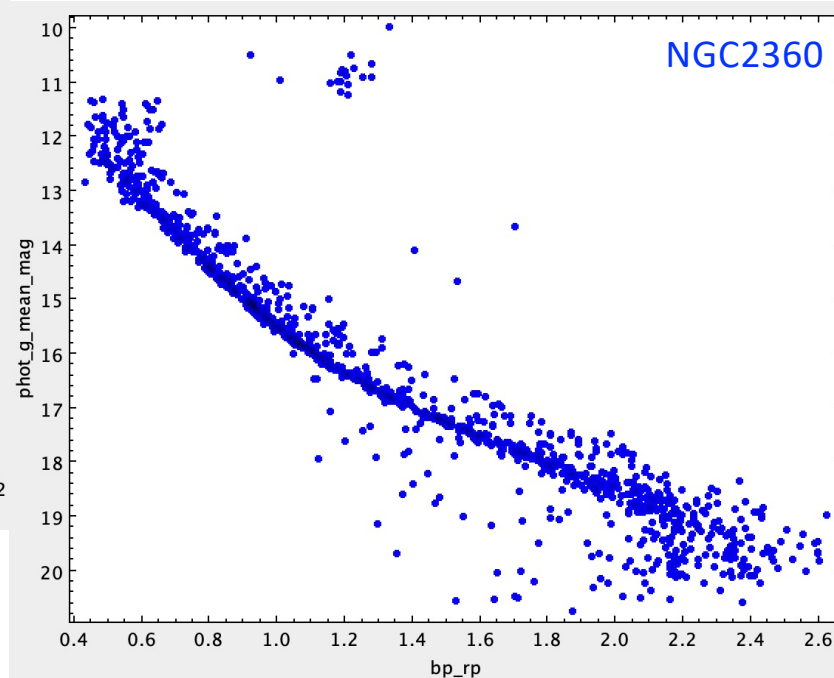
NGC 2509 – FLAMES@VLT

NGC2509: age=1.6 Gyr [*Hunt&Reffert 2003*]
NGC2360: age=1.4 Gyr

Not in Gaia-ESO

Proposal ESO P112
AB, Ricardo Carrera,
Valentina D'Orazi,
Sara Lucatello, Antonella
Vallenari
Deciphering NGC 2509, an
intermediate-age open
cluster with a large binary
population and a narrow
turn-off

3 hrs, FLAMES
UVES U580
GIRAFFE #11, 12, 15n

18

NGC 2509 – FLAMES@VLT

NGC 2509

16 UVES
103 GIRAFFE
(HR11, 12, 15n)

3 hrs, FLAMES
UVES U580 & GIRAFFE #11, 12, 15n

HR11:   5597-5840 Å, R=29500
HR12:   5820-6146 Å, R=20250
HR15n: 6470-6790 Å, R=19200
U580:   4800-6800 Å, R=45000

HR11:   Fe, Na
HR12:   Ba
HR15n: Mg, Al, Li
UVES: all them & more

3 OBs well separated → binaries

>200 high-probability members with G<18
80 stars G<14.5 in Gaia-RVS (RV, Vbroad)