

Deriving the parameters of a population (SSP) fitting a spectrum

M. Koleva^{1,2}, Ph. Prugniel^{1,3}, P. Ocvirk⁴, D. Le Borgne⁵,
I. Chilingarian^{1,6}, P. Blonde¹, V. Golev²

¹ CRAL Observatoire de Lyon, University Claude Bernard

² Department of Astronomy, University of Sofia St. "Kliment Ohridski"

³ GEPI Observatoire de Paris

⁴ University of Central Lancashire

⁵ IAS Orsay

⁶ MSU Stenberg Astronomical Institute, Moscow

Population Pixel Fitting

Derive the population parameters from the full spectra

- Validation of the 3 major steps
 - stellar libraries
 - population synthesis
 - inversion method

==> compare various codes and methods
- Validation on real data (SSPs)
 - ==> Galactic GCs and M67

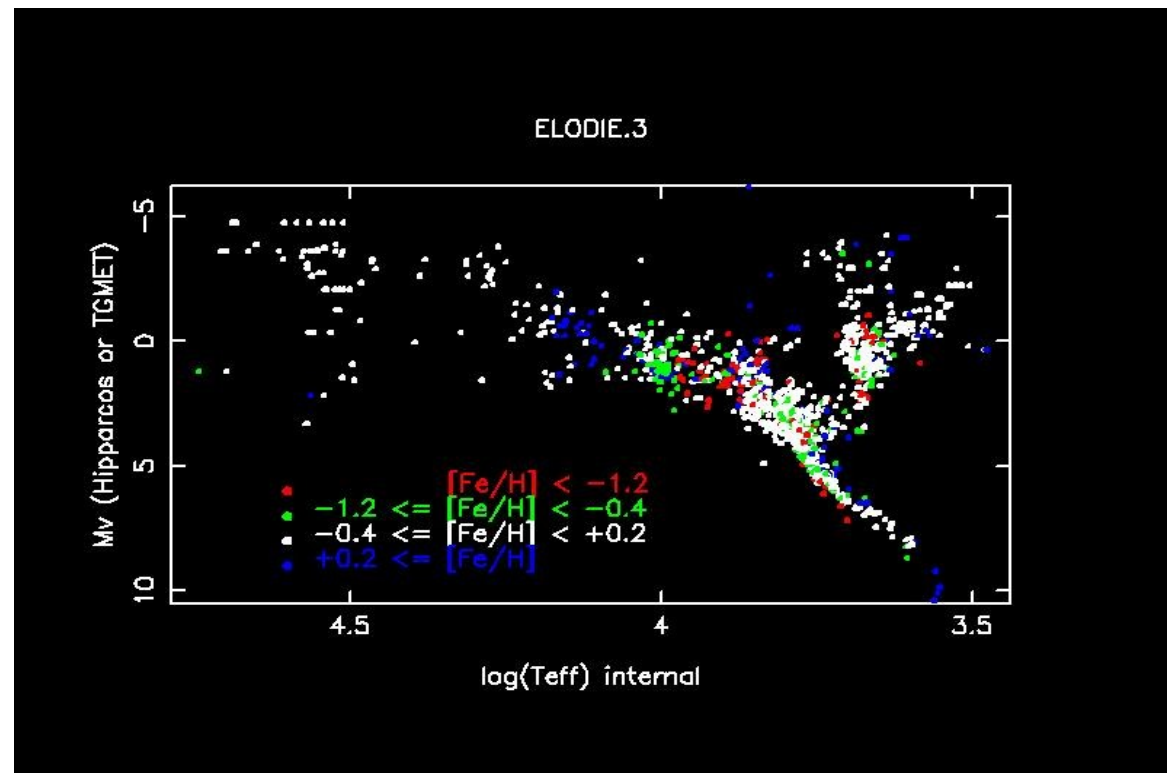
The Model

- Stellar library - **Elodie 3.1**
- Code for computing synthetic evolutionary spectra of
galaxies - **Pegase HR**
- Fitting procedure - **NBURSTS**

The Model

- **Elodie 3.1**

- 1961 Spectra
- 1500 Stars
- $R = 10\,000$
- $wl [3900, 6800]$
- extended coverage of parameters space



**The empirical library with largest set of stars,
high resolution and fair flux calibration**

http://www.obs.u-bordeaux1.fr/m2a/soubiran/elodie_library.html

The Model

- Pegase HR (Le Borgne et al 2004)

- SSP, CSP, self consistent

<http://www2.iap.fr/pegase/pegasehr/>

- **NBURSTS** we are fitting simultaneously parameters of the template (Age, Z); of the Line-of-Side Velocity Distribution (cz, σ) and polynomial (P) of degree n in pixel space using Penalized Pixel Fitting (pPXF) method described in Cappellari & Emsellem, 2004.

$$\text{Obs}_{\text{px}} = P_n^* (\text{Template}(\text{Age}, Z) \otimes \text{LOSVD}(cz, \sigma))$$

Validation

To test our method we inverted:

- **synthetic SSPs** from other authors (BC03; Vazdekis)
- **real data**: GCs (Schiavon, R. et al 2005) and M67 (Schiavon, R. et al 2004)

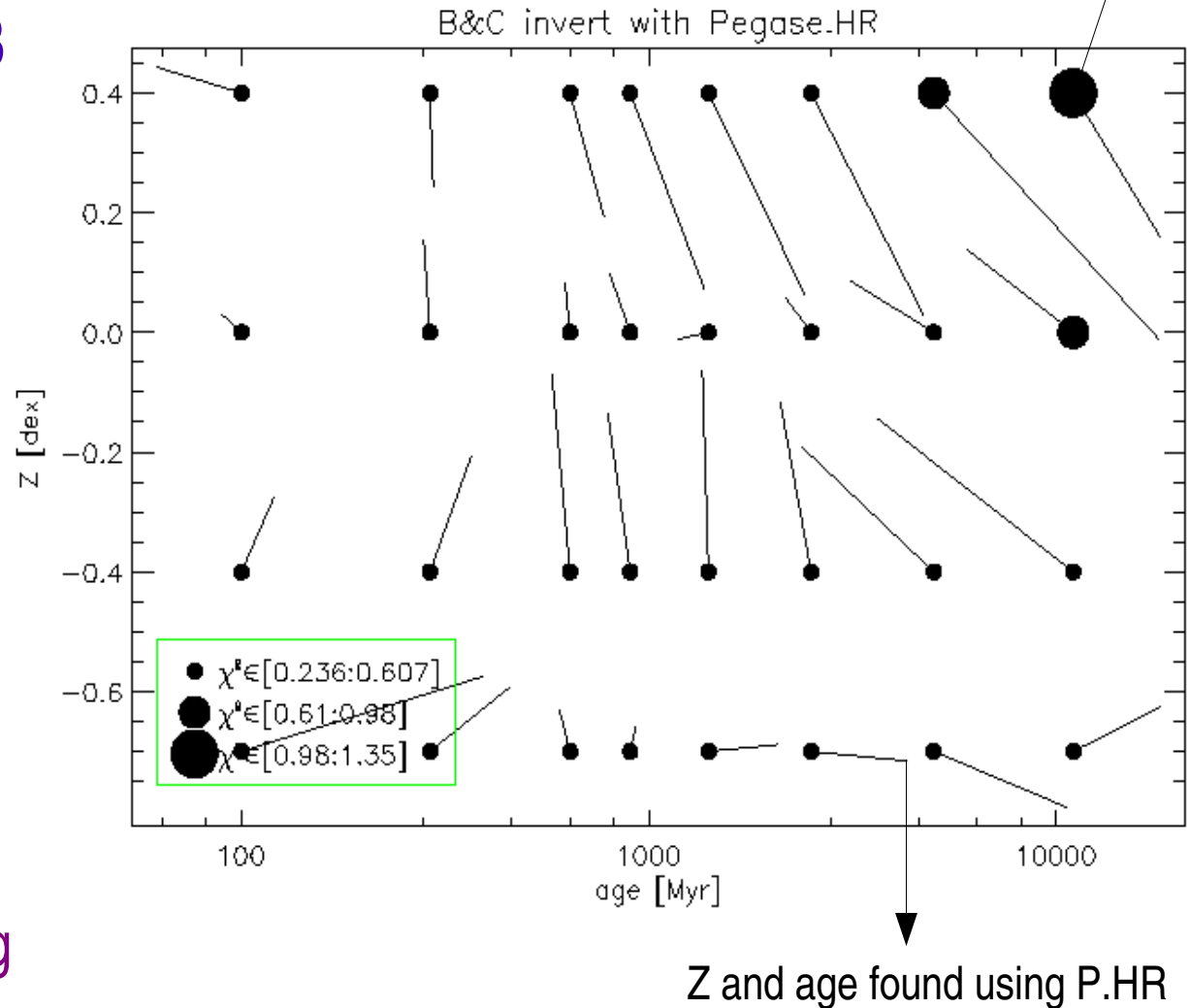
Validation - I

Comparison with SSPs models Point from BC03 grid

Grid of SSPs from BC03
(SteLib) invert with
Pegase HR (Elodie
3.1)

Results:

- **Consistent**
- **Systematic effects**
(metallicities of -0.4dex
and +0.4dex from the
grid of BC03 are finishing
with solar Z)



Validation I

Comparison with SSPs models

To investigate where is the problem with systematic effect found with BC03 (SteLib) we inverted SSPs from Vazdekis (kindly provided by him on this conference) with MILES stellar library.

Vazdekis (MILES)

Age	Z
5 Gyr	0.2 dex
5 Gyr	0 dex
5 Gyr	-0.4 dex



Pegase HR (ELODIE 3.1)

Age	Z
4.8 Gyr	0.23 dex
4.5 Gyr	0.03 dex
4.5 Gyr	-0.34 dex

Validation I

Comparison with SSPs models

Conclusions:

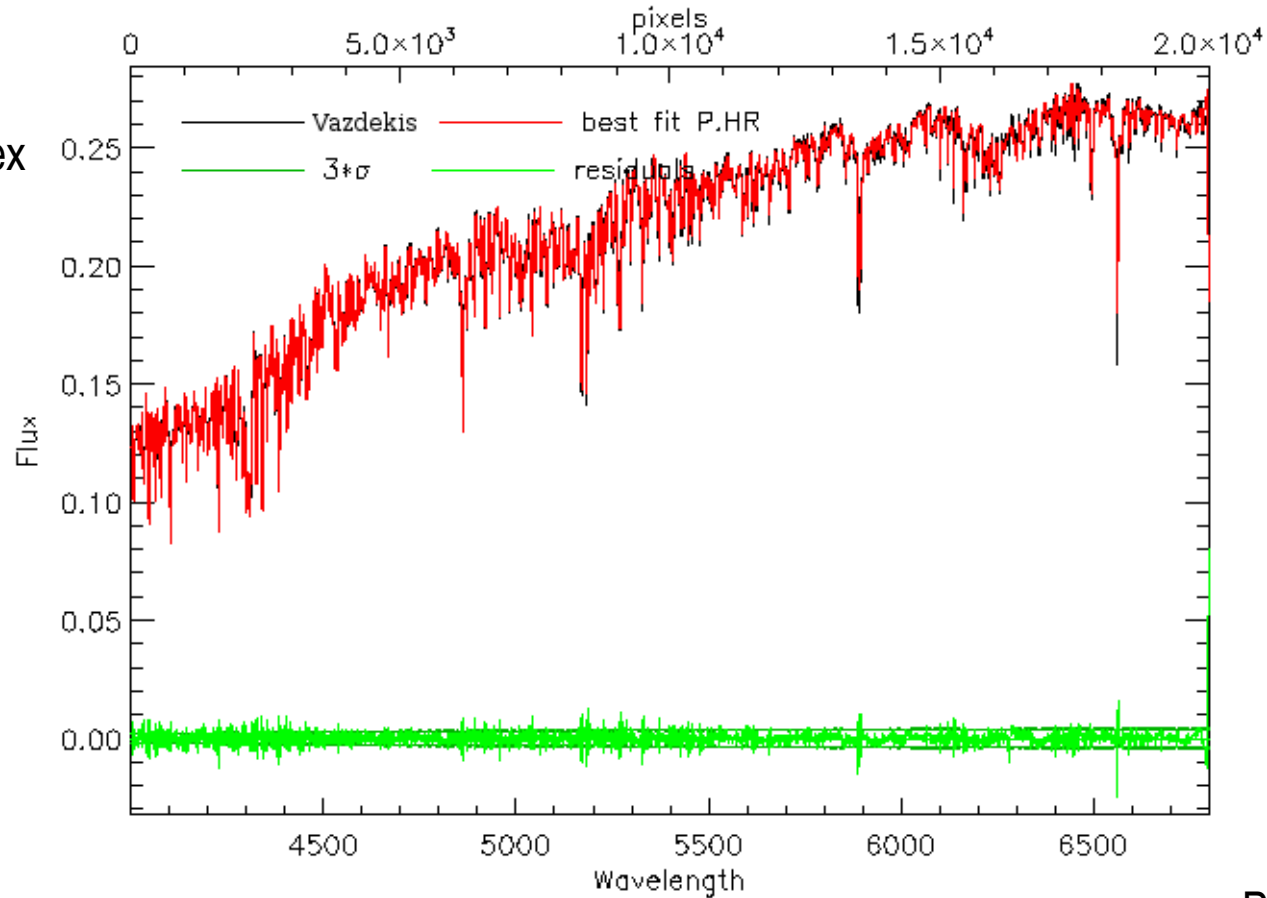
- Pegase HR SSPs are consistent with other synthetic libraries
- Systematic effect found inverting BC03 with Pegase HR is due to SteLib

Validation I

Comparison with SSPs models

Example of one of the fitted spectra

Vazdekis
5 Gyr - 0.4 dex



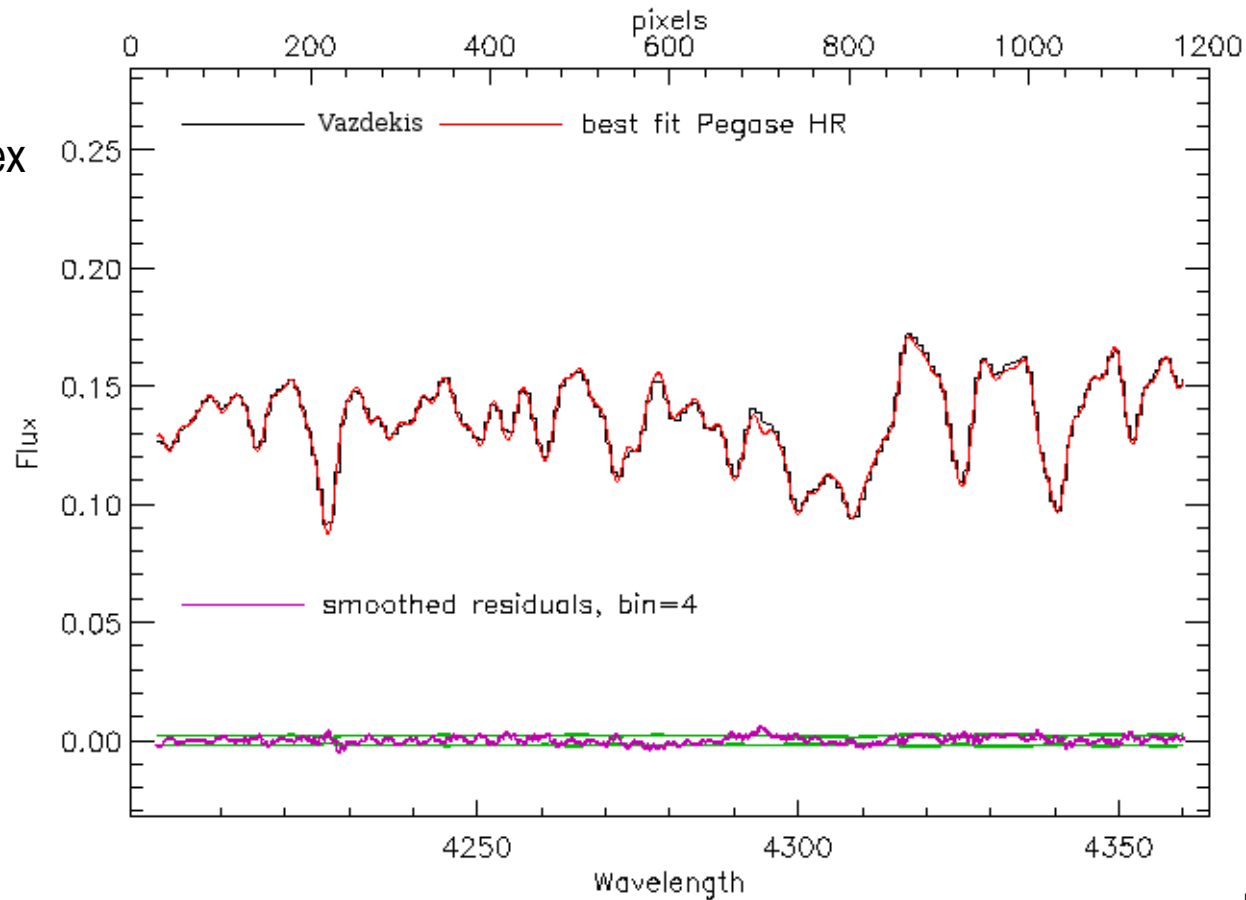
Pegase HR
4.5 Gyr -0.34dex

Validation I

Comparison with SSPs models

Zoom in G band region

Vazdekis
5 Gyr - 0.4 dex



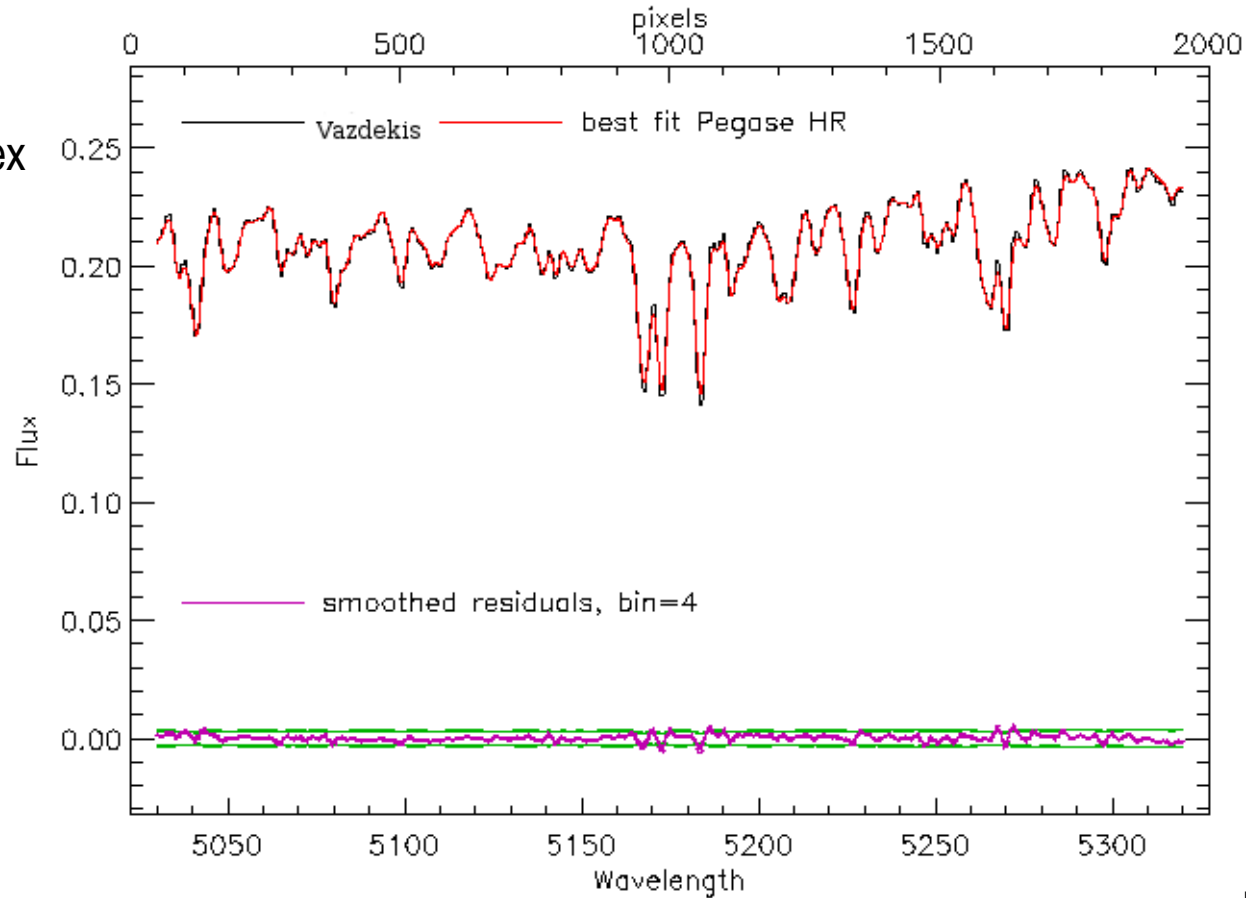
Pegase HR
4.5 Gyr -0.34dex

Validation I

Comparison with SSPs models

Zoom in the Mg2 region

Vazdekis
5 Gyr - 0.4 dex



Pegase HR
4.5 Gyr -0.34dex

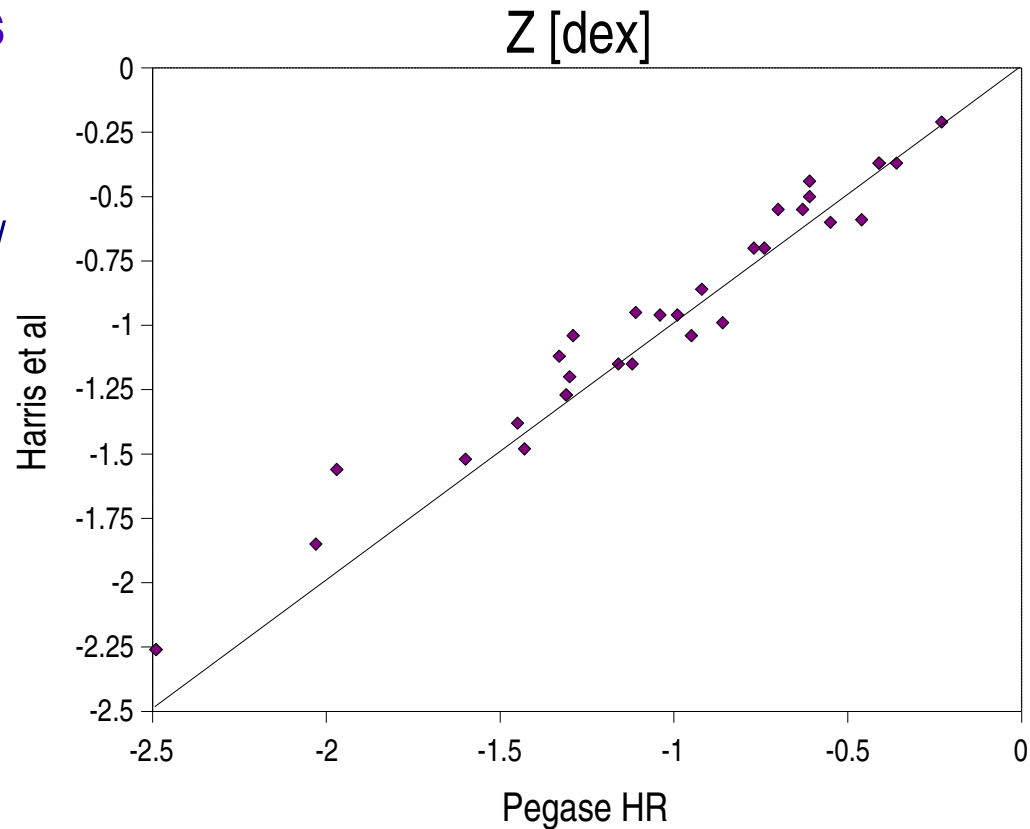
Validation II

Fit observed clusters

Comparison between metallicities found with our method and metallicities from Harris (<http://www.physics.mcmaster.ca/Globular.html>) for Galactic GCs (Schiavon, R. 2005)

Conclusions:

- Excellent agreement
- Scatter is very small
- Small bias



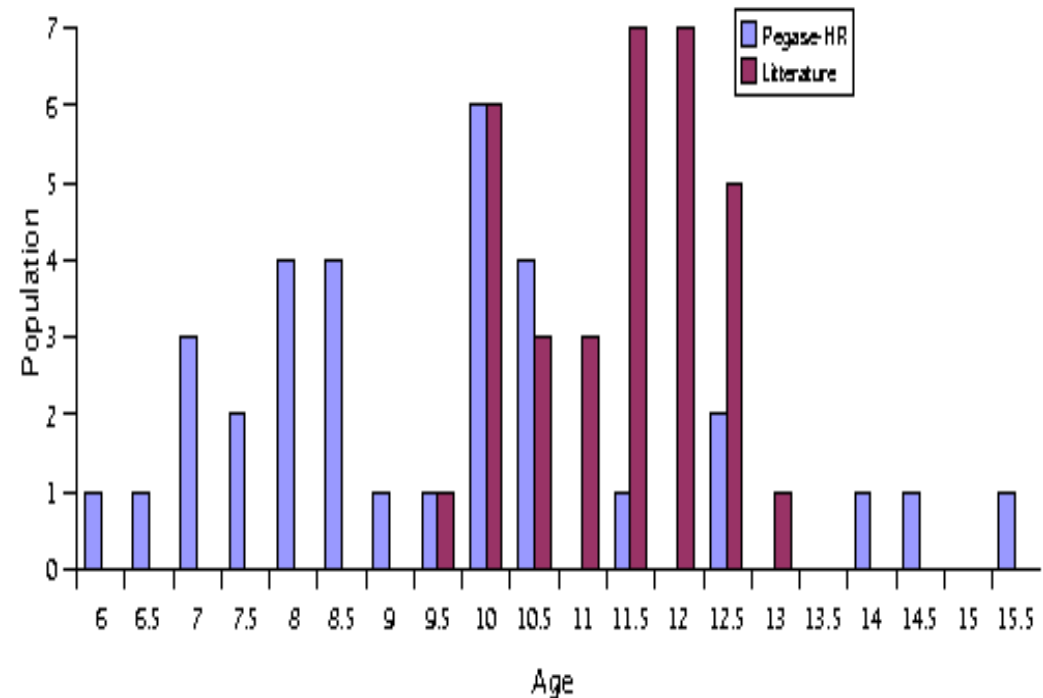
Validation II

Fit observed clusters

Comparison between ages found with our method and ages taken from the literature of galactic GCs from Schiavon, R. (2005)

Conclusions:

- Consistency
- For some of the GCs we found younger ages (possibly due to Blue Horizontal Branch)



Validation II

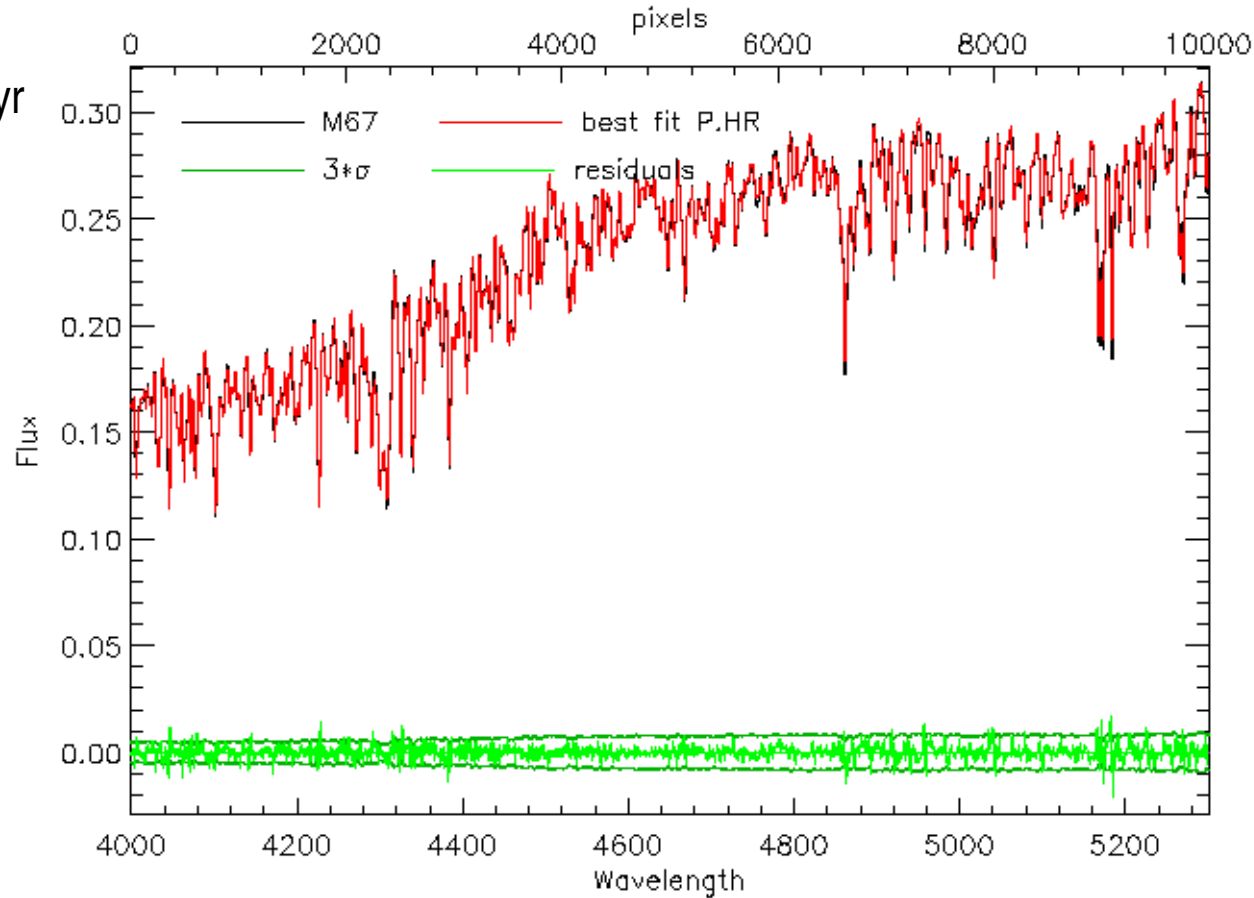
Fit observed clusters

Fitting M67 (provided by Schiavon, R.)

Found:

AGE = 4911 Myr

Z = -0.11 dex



Validation II

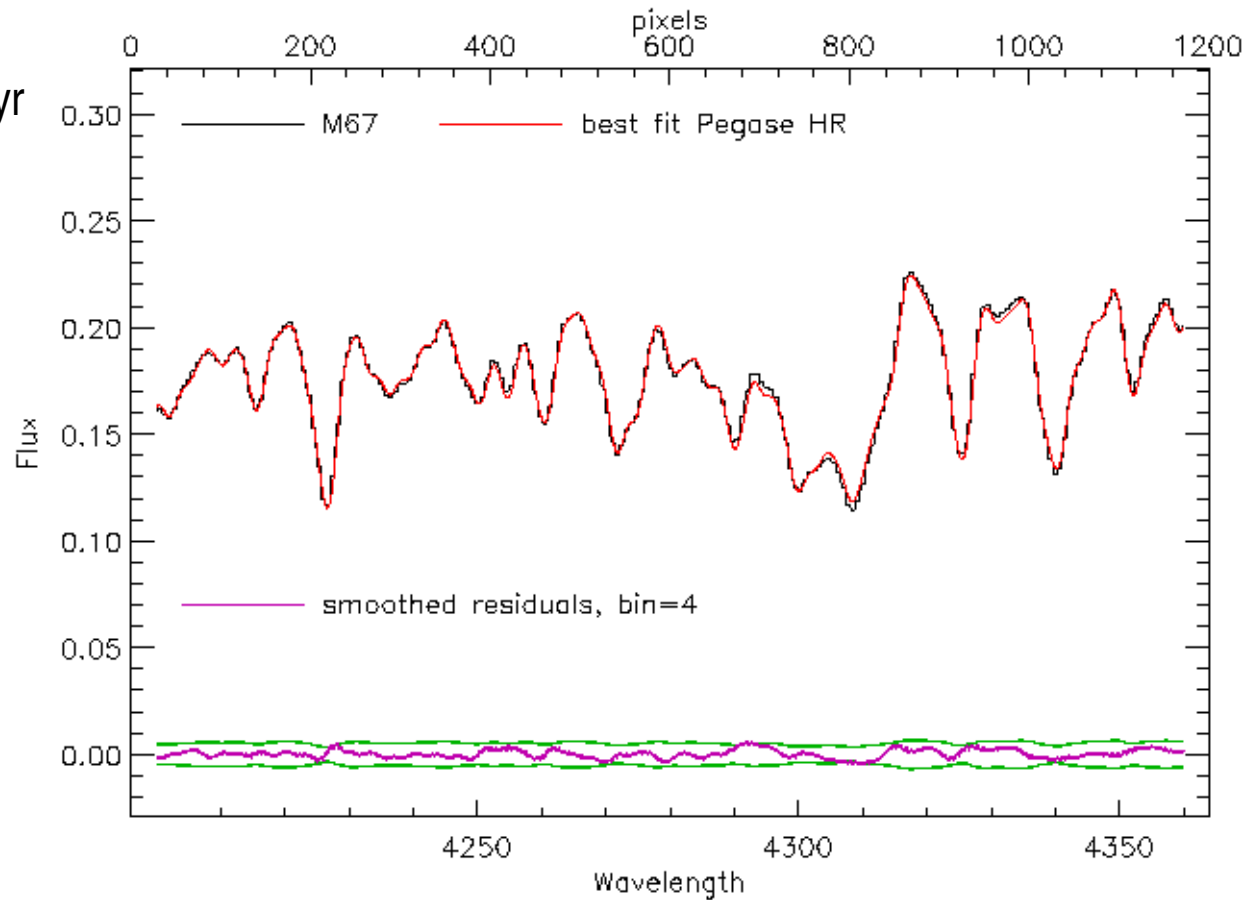
Fit observed clusters

Zoom in G band region

Found:

AGE = 4911 Myr

Z = -0.11 dex



Validation II

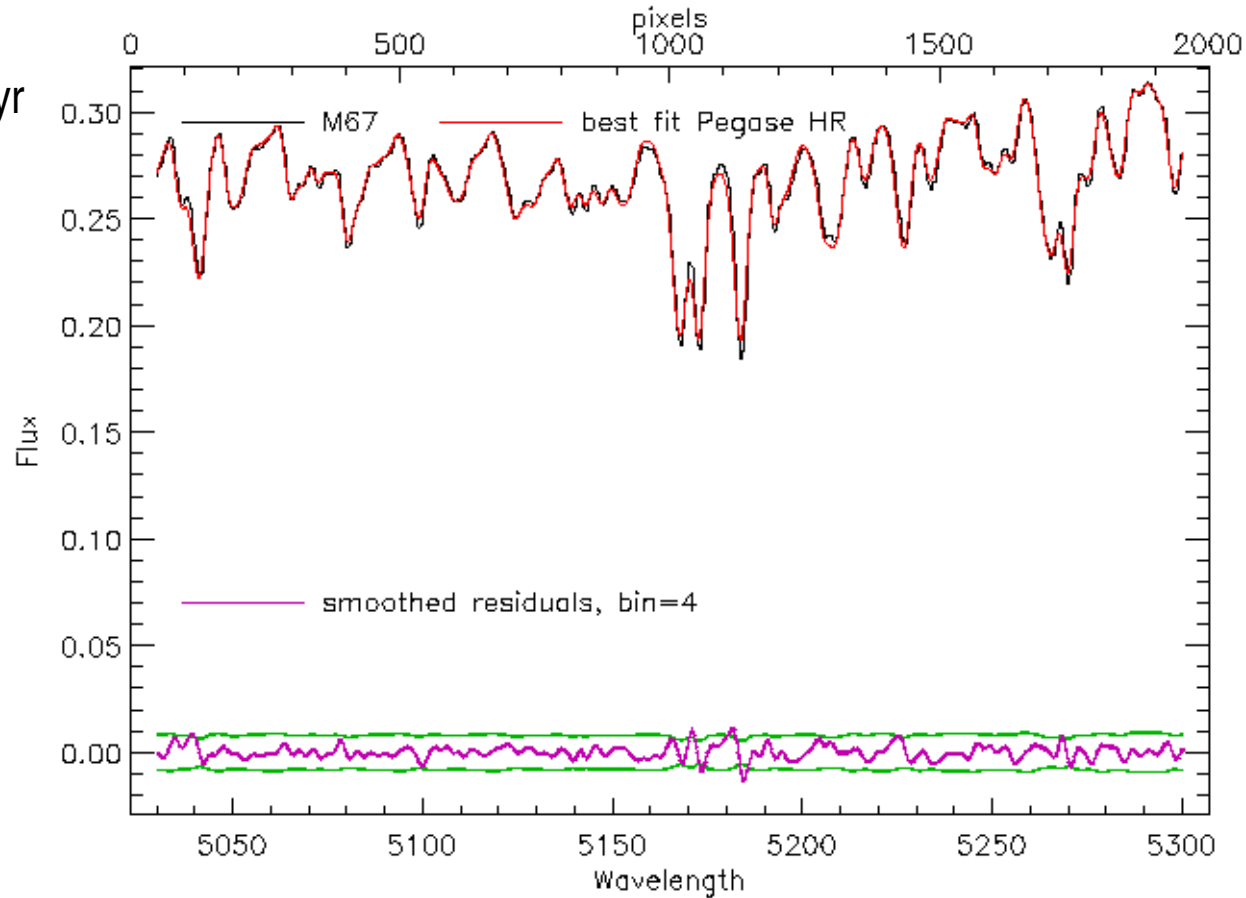
Fit observed clusters

Zoom in the Mg2 region

Found:

AGE = 4911 Myr

Z = -0.11 dex



CONCLUSIONS

- The different libraries and SSPs (BC03, Pegase HR, Vazdekis) are consistent
- Population pixel fitting vs. spectrum photometric indices
 - Age and Z are consistent with Lick indices
 - Error bars are 3 times smaller
- Limitations of fitting spectra
 - Presently limited to the abundances of the stellar libraries
 - Wait for libraries with variable [Mg/Fe]

(see Coelho et al 2005 & this conf.; Soubiran & Prugniel in prep.)

• References

- Prugniel & Soubiran 2001, A&A, 369 1048
- Le Borgne et al, 2004, A&A, 425 881
- Cappellari & Emsellem, 2004, PASP, 116, 138.
- Bruzual & Charlot, 2003, MNRAS, 344, 1000
- Harris W., 1996, AJ, 112, 1487
- Schiavon, R. et al, 2005, ApJS, 160, 163
- Schiavon, R. et al 2004, AJ, 127, 1513
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