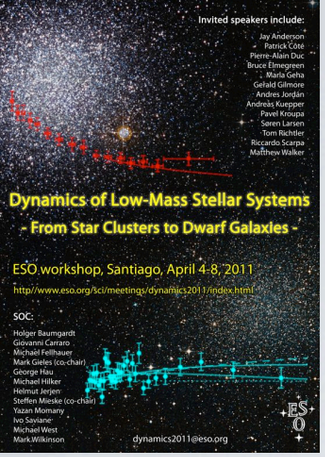

Ages and metallicities of nuclear clusters in dwarf galaxies

and their relation to massive Galactic GCs

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Argelander-Institut für Astronomie

Thomas **Puzia**, Michael **Hilker**, Paul **Goudfrooij**, Holger **Baumgardt**

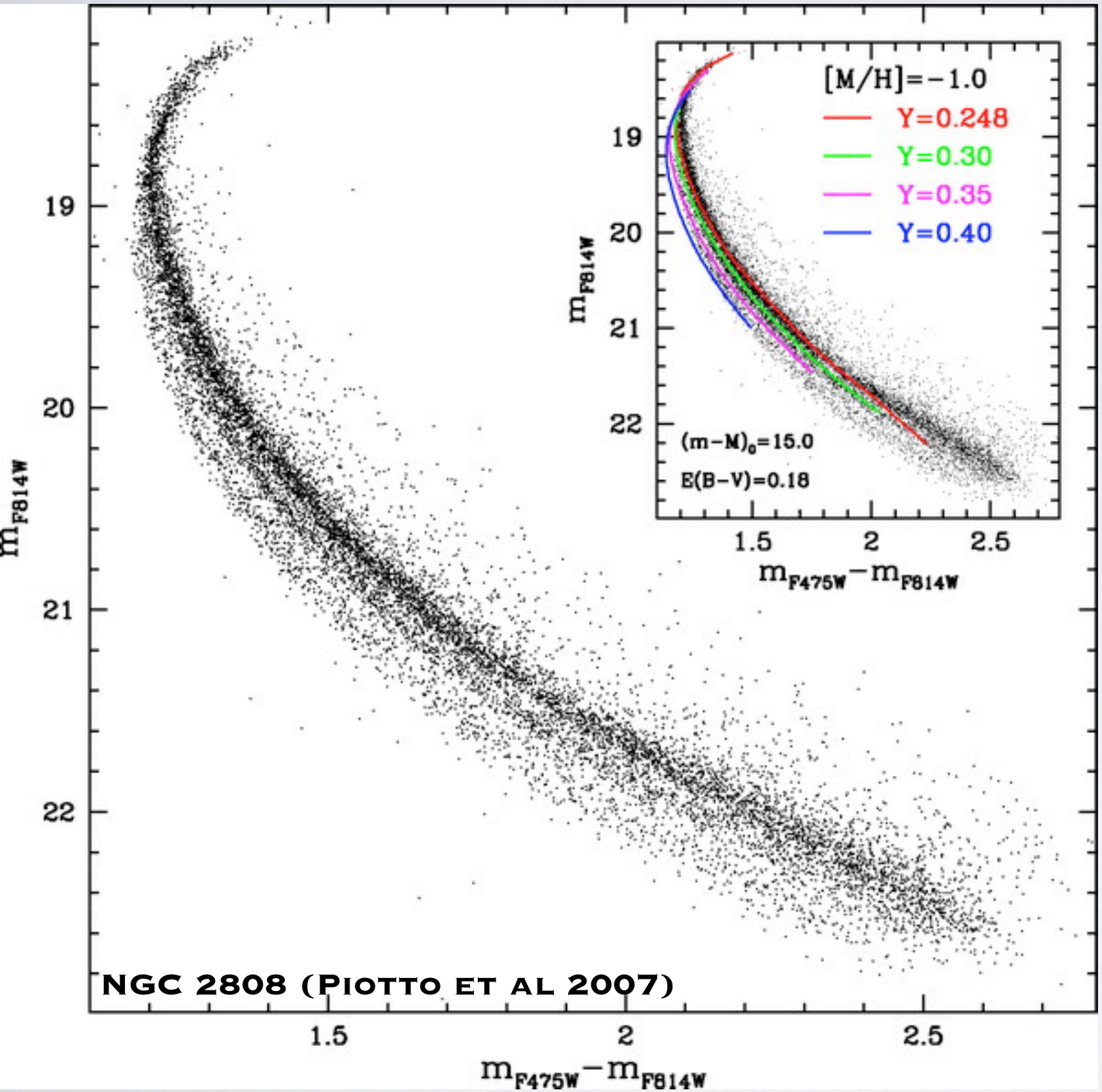
Outline

The not so normal Galactic GCs

Nuclear GCs in Dwarf Galaxies

Both formed in similar environment?

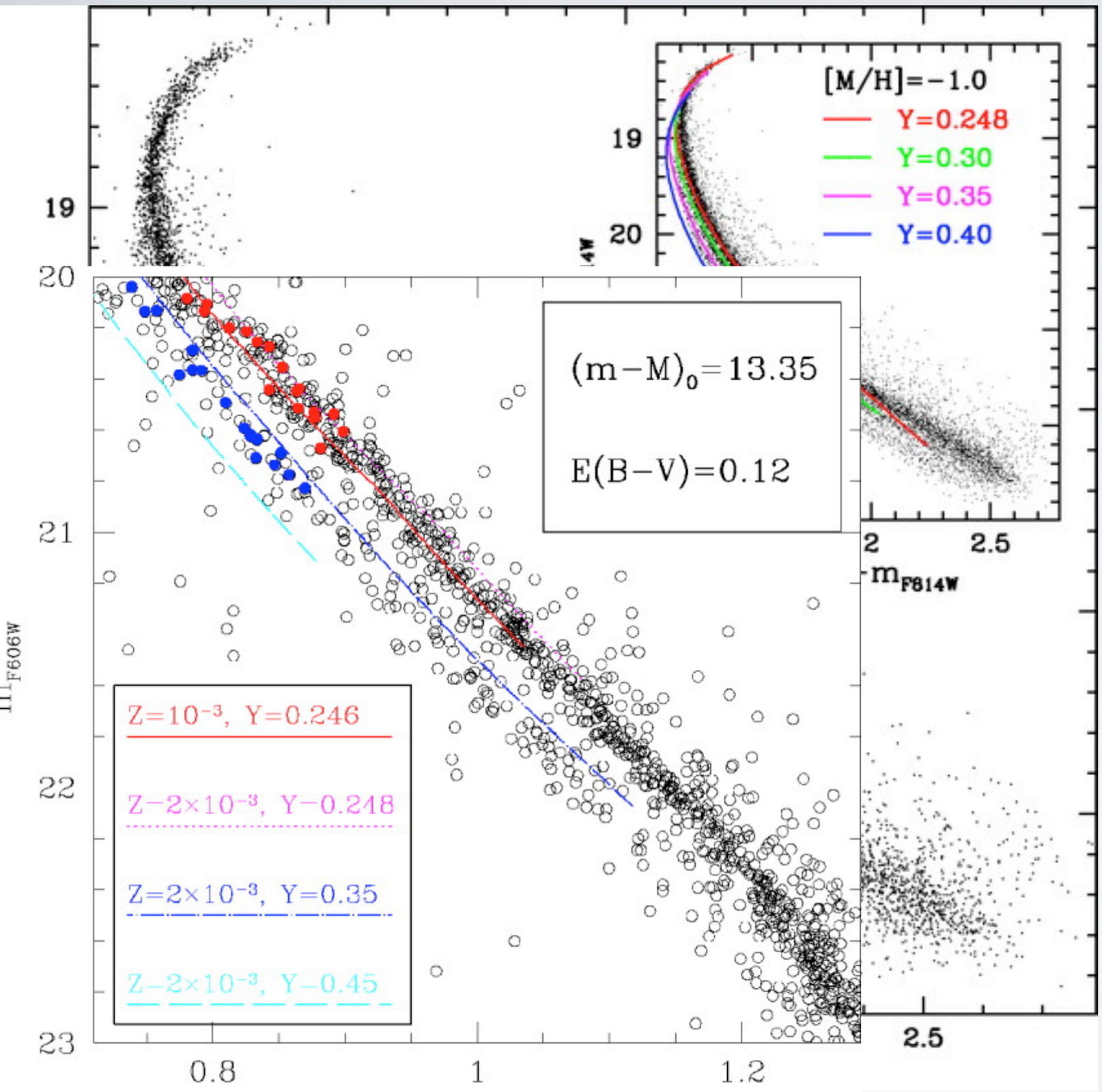
The not so normal Galactic GCs



Complex Populations

- split in MS, RGB, SGB, HB
- large spread in light elements
- High helium abundance
- one dominant population (e.g. 75% ωCen, 65% NGC 2808)

The not so normal Galactic GCs



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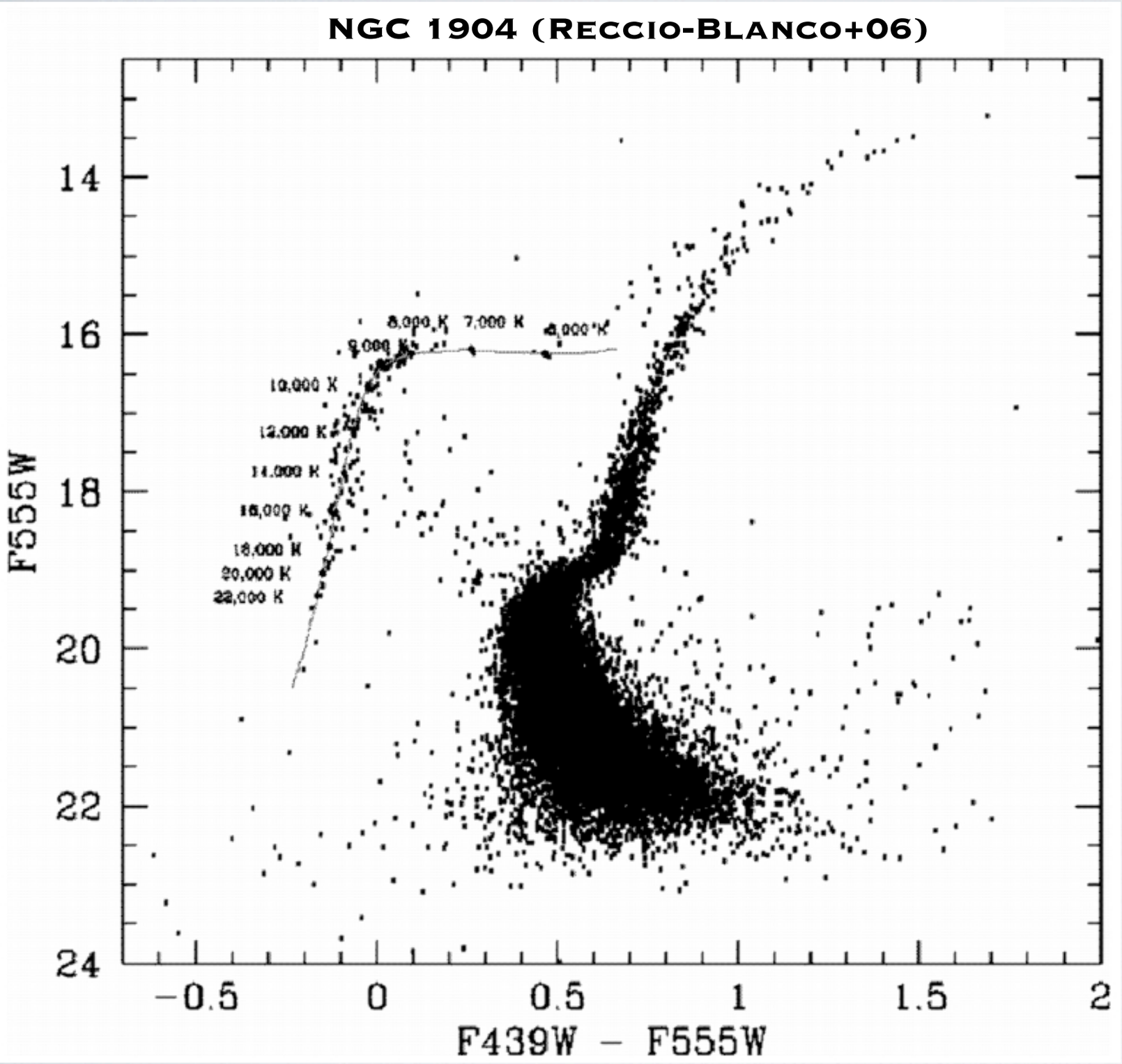

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Hot Horizontal Branch

- Hot HB stars $T_{EFF} > 10^4$ K
- HB morphology strong function of mass (e.g. Recio-Blanco'06)

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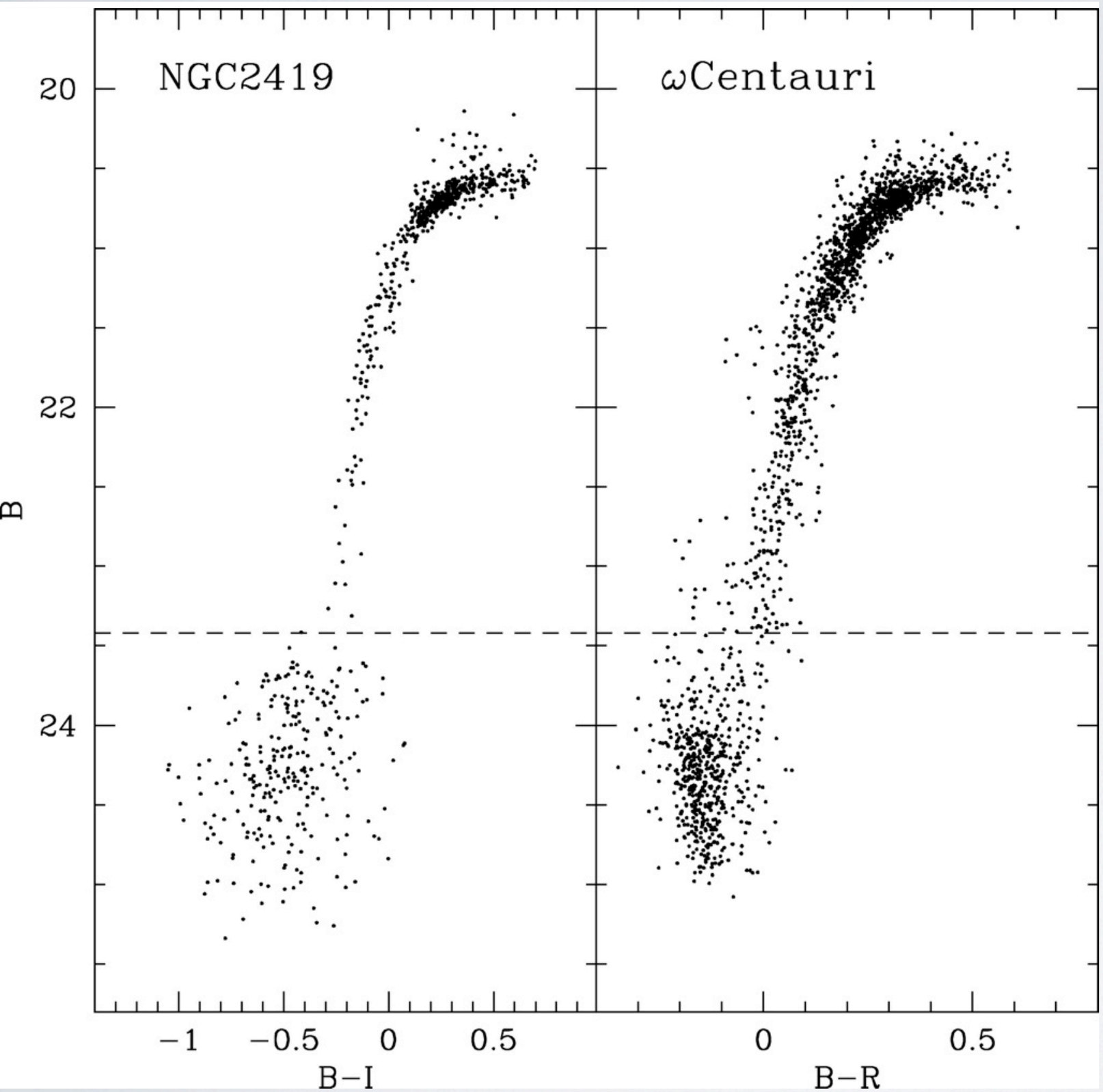

Dalessandro+08 Ferraro+04

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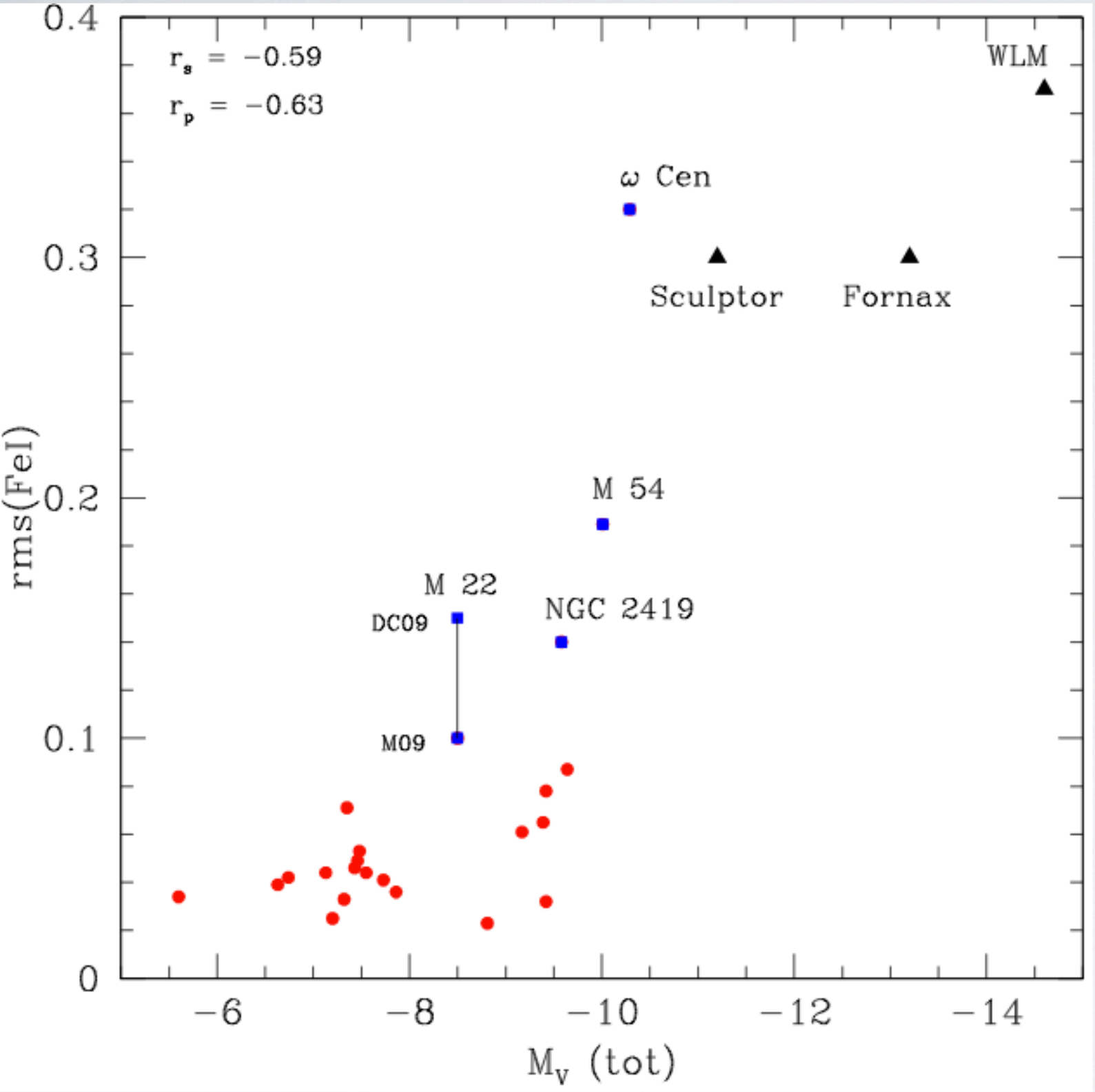

Carretta et al. (2010)

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Mass - metallicity

Spread in iron

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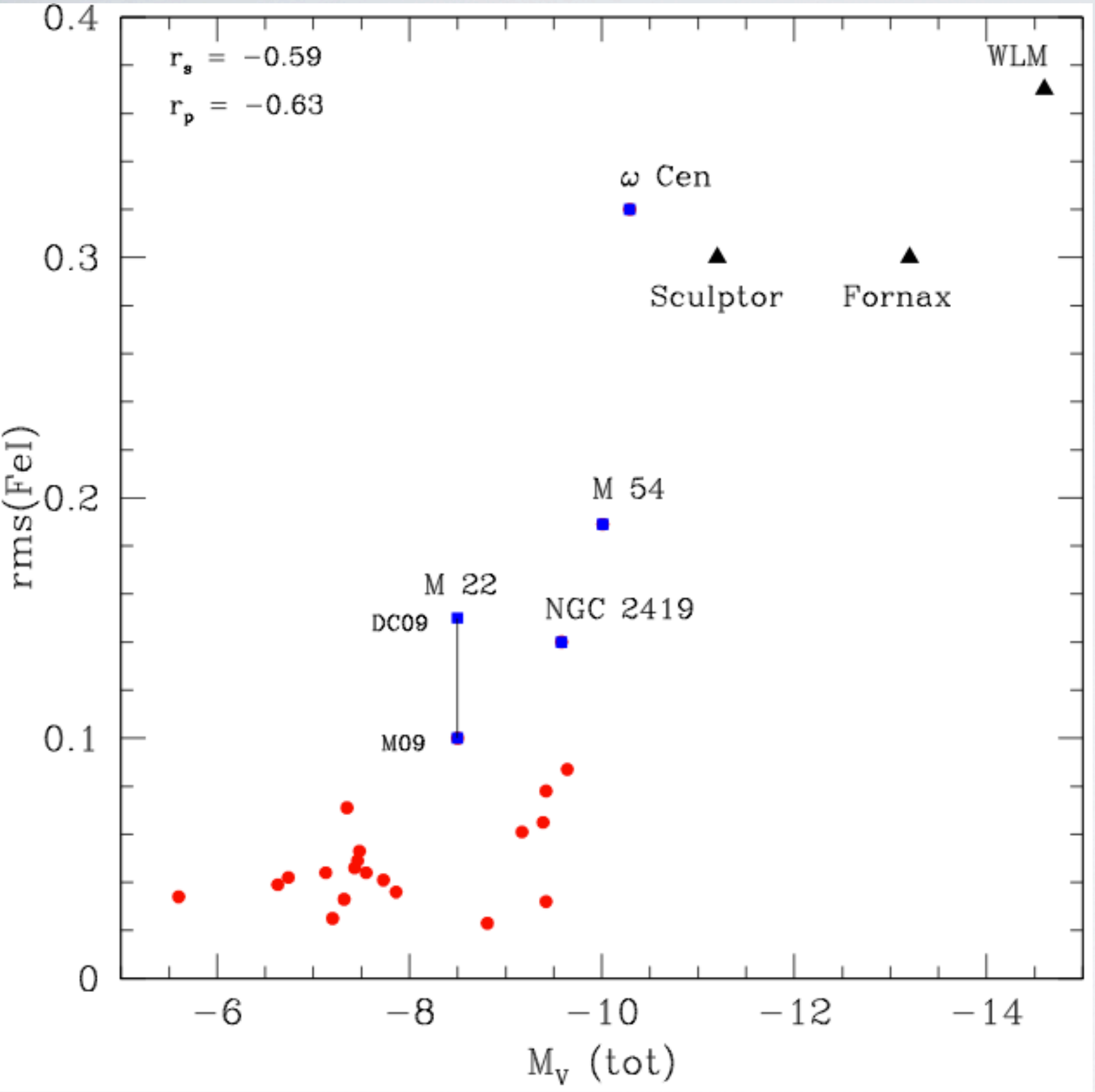

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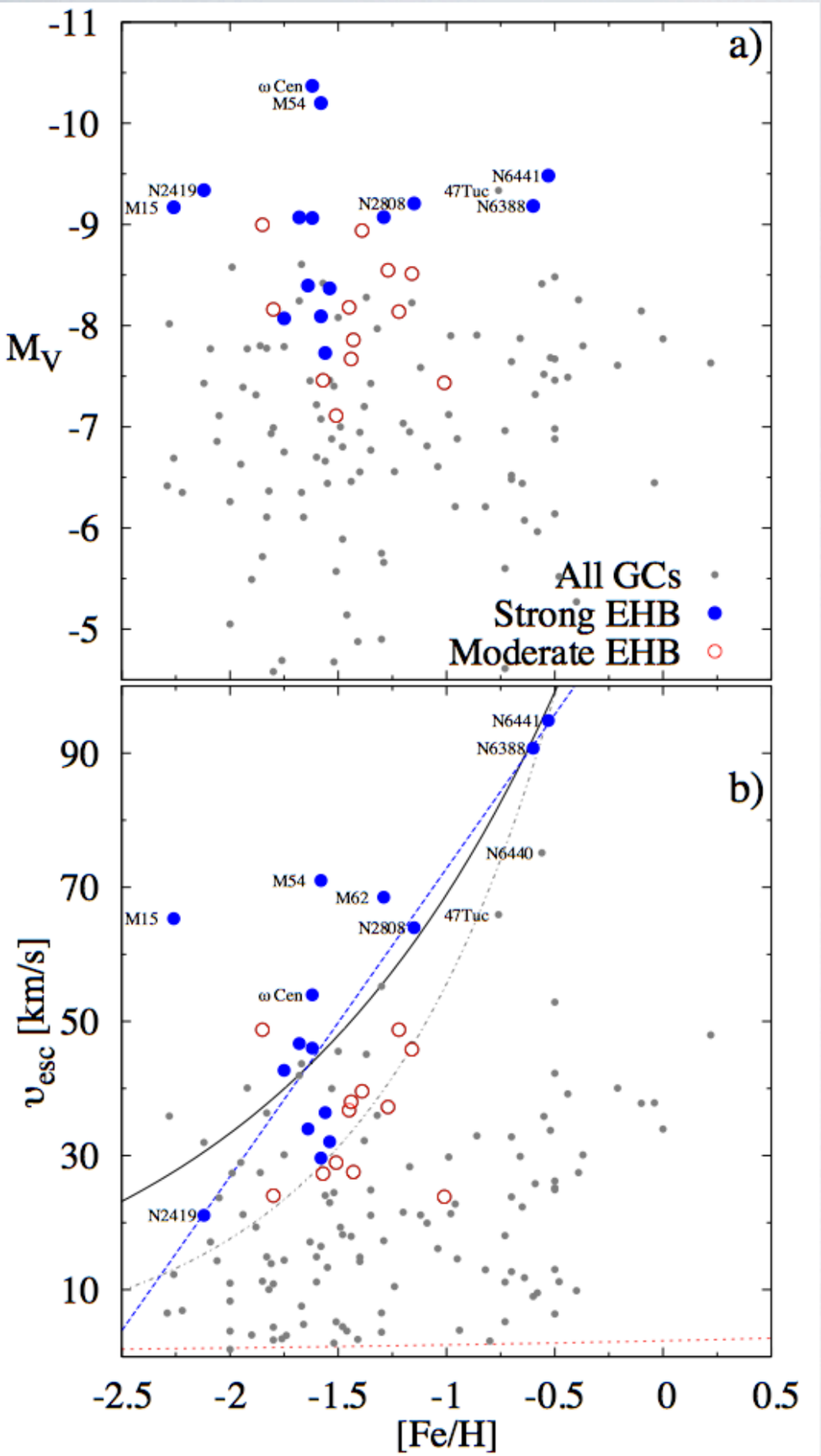
Mass - metallicity

Spread in iron

Deep potential

Formed as nuclei?

The not so normal Galactic GCs



Central Escape velocity to tidal radius

$$v_{esc} = f_c \sqrt{\frac{M_{cl}}{r_h}} \ [\mathrm{km/s}]$$

- Self enrichment if $v_{wind} < v_{esc}$
AGB~20 km/s (D'Antona+01,08)
Fast rotators <100 km/s (Decressin+07)

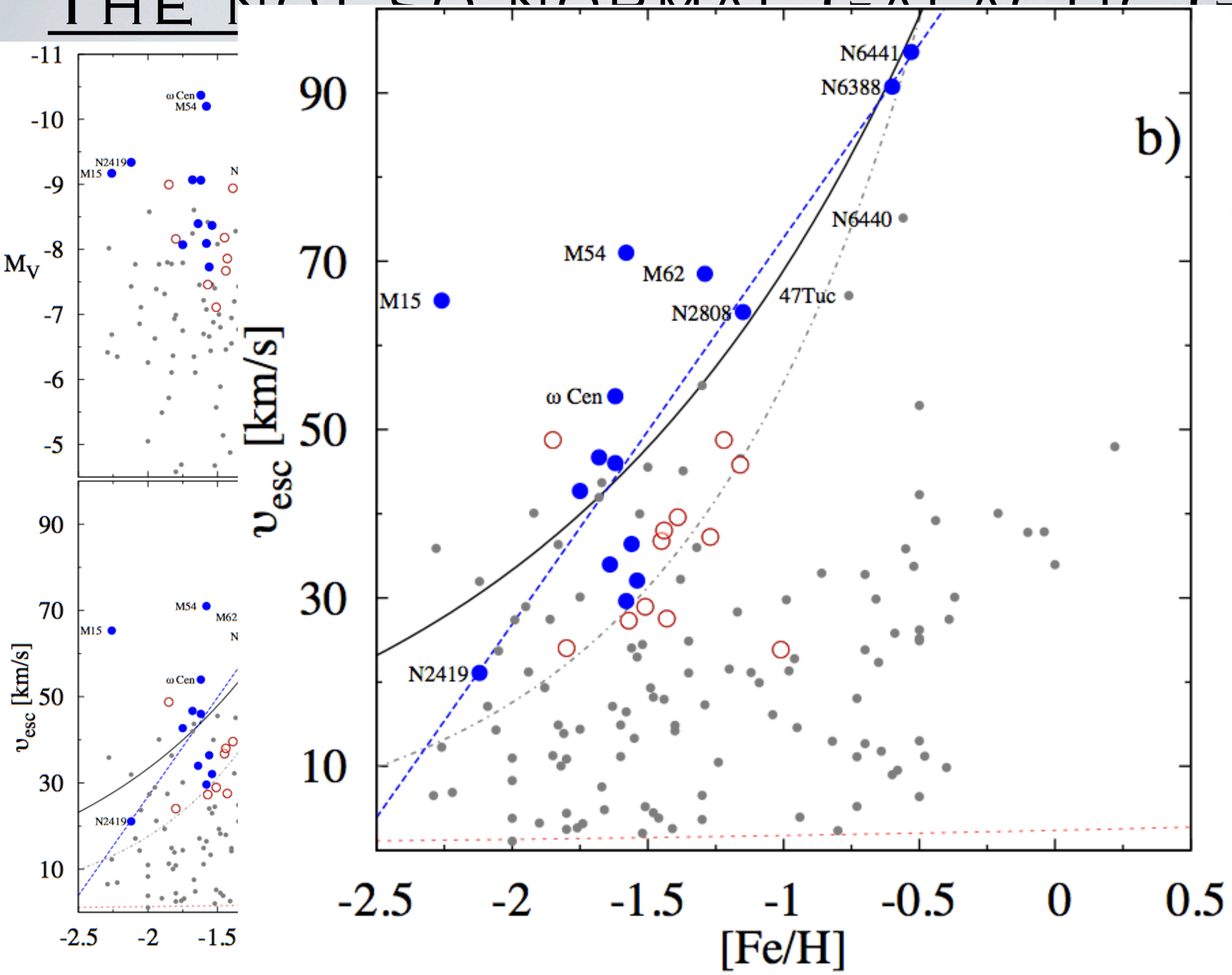
$v_{wind} \sim Z^{0.5} L^{0.25}$ (Marshal+04)

- Metal enrichment by recurrent gas accretion (Pflamm-Altenburg & Kroupa 2009)

Georgiev et al. (2009b)

THE NOT SO NORMAL GALACTIC GCs

RADIUS



GAS

009)

. (2009B)

ESO 059-01

ESO 223-09

IC1959

◆ 68 dwarf galaxies with M_V > -17 mag at D = 2 – 10 Mpc (Georgiev et al. 2008,2009a)

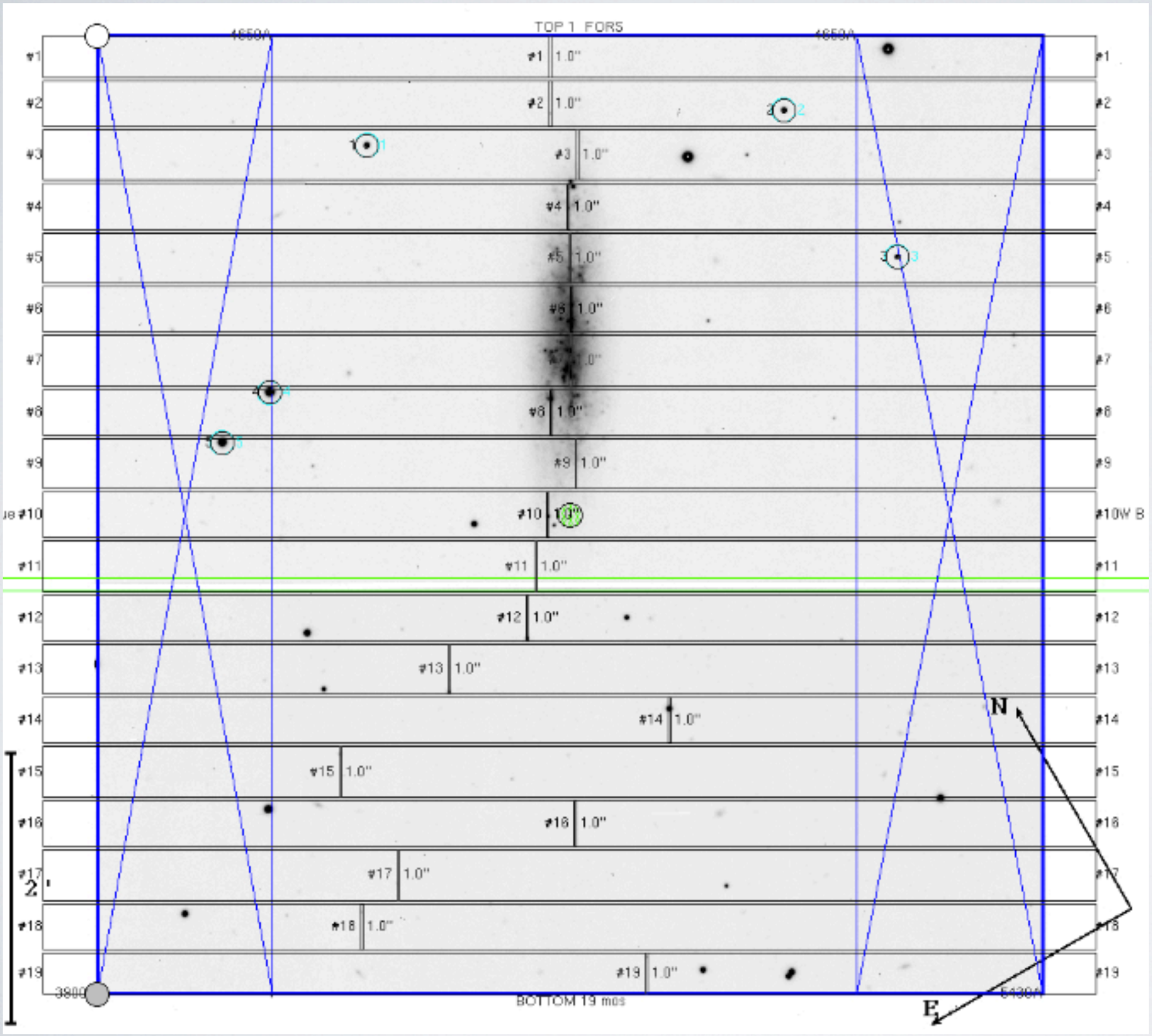
◆ 7 (10%) “nucleated” dIrrs (Georgiev et al. 2009b) ◆ High S_L (Georgiev et al. 2010)

KK 197

ESO 269-58

NGC 1311

Spectroscopy of Nuclear GCs



VLT/FORS2

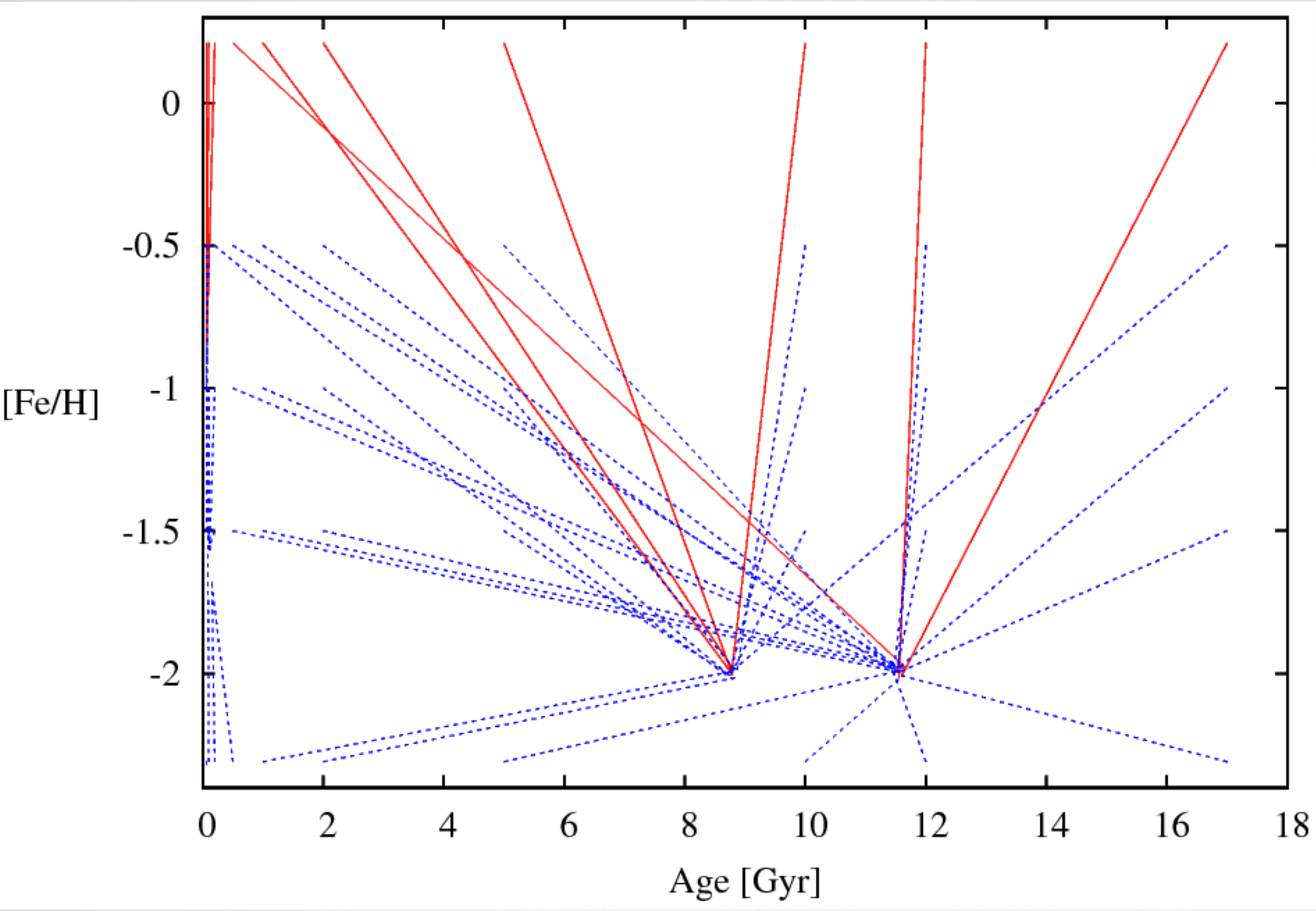
Grism 600B

MOS

3300-6210A

1.5 A / pix

Ages and Metallicities of Nuclear GCs

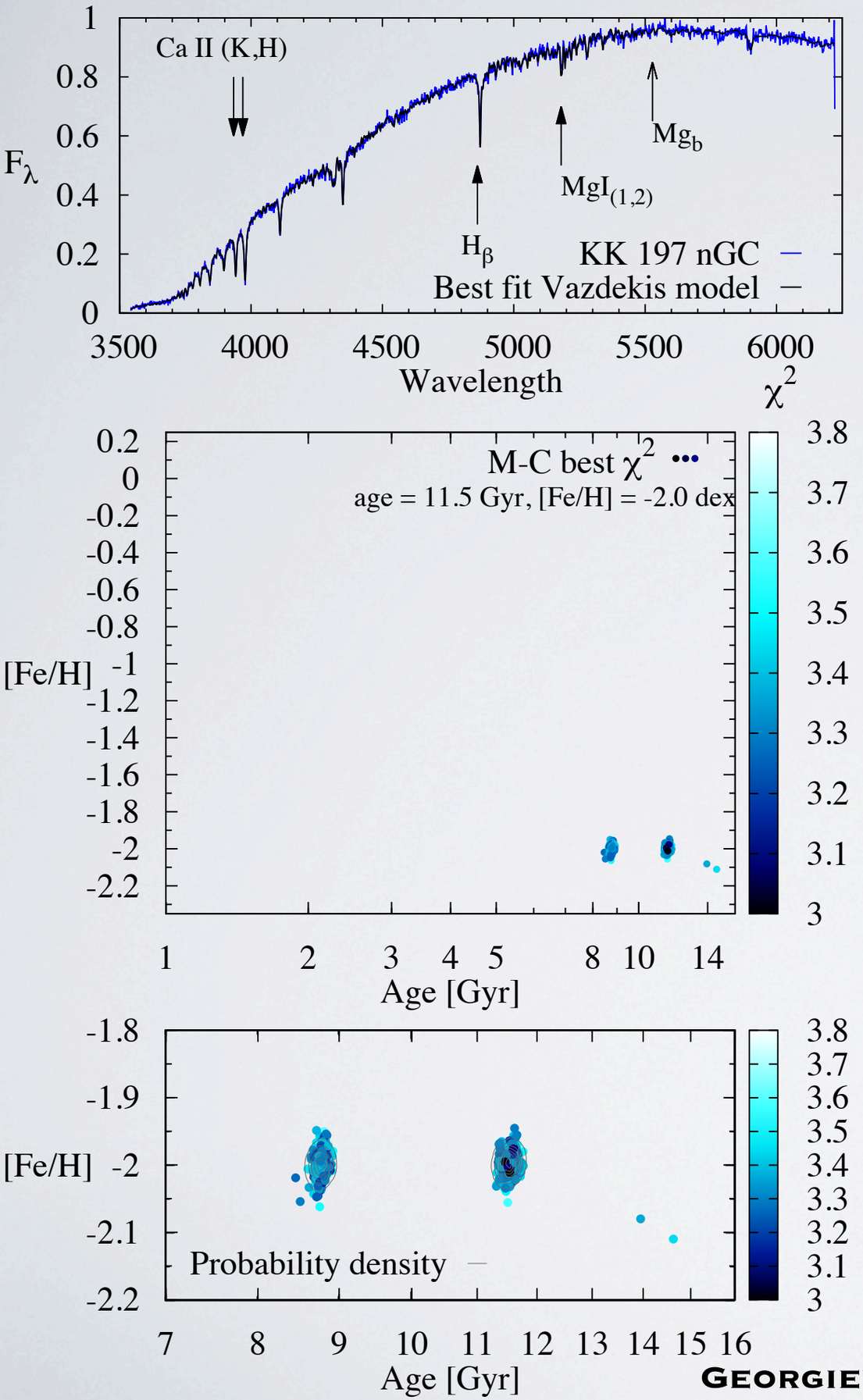


Full Spectral Fitting (Ulys, Koleva et al. 2009)

Vazdekis models (2010)
60 Myr < Age < 18 Gyr
-2.3 < [Fe/H] < 0.2 dex

Georgiev et al. (2011, in prep.)

Ages and Metallicities of Nuclear GCs



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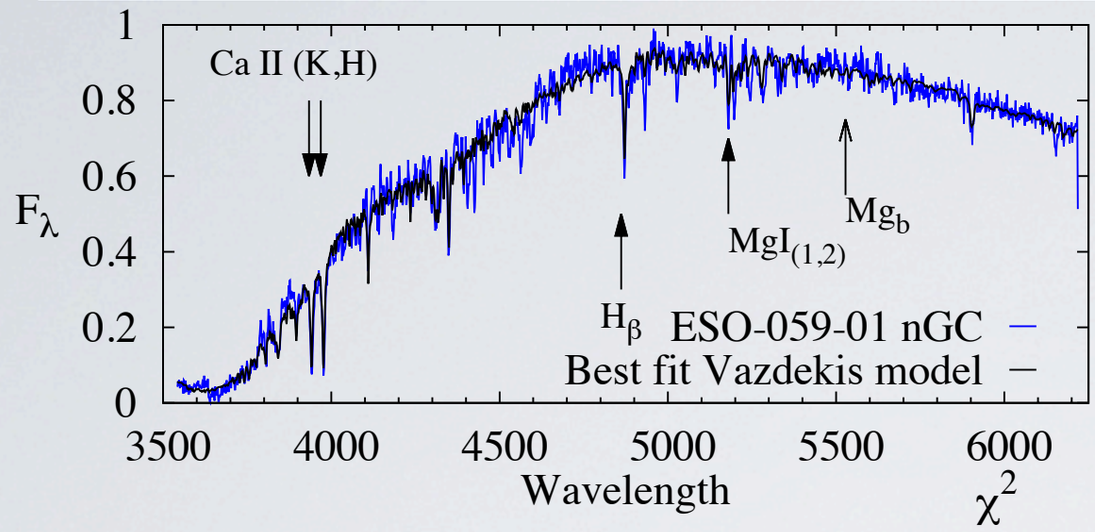
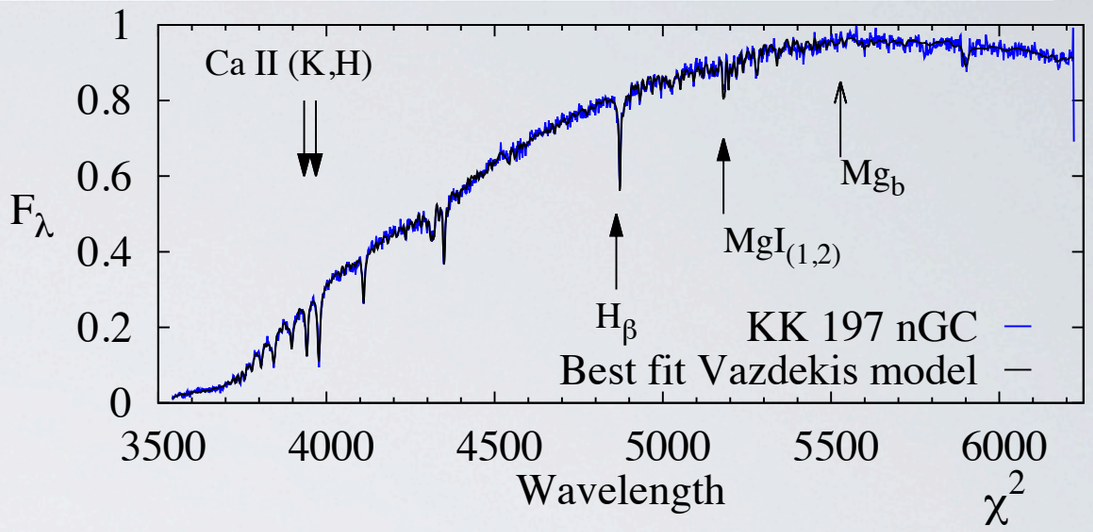
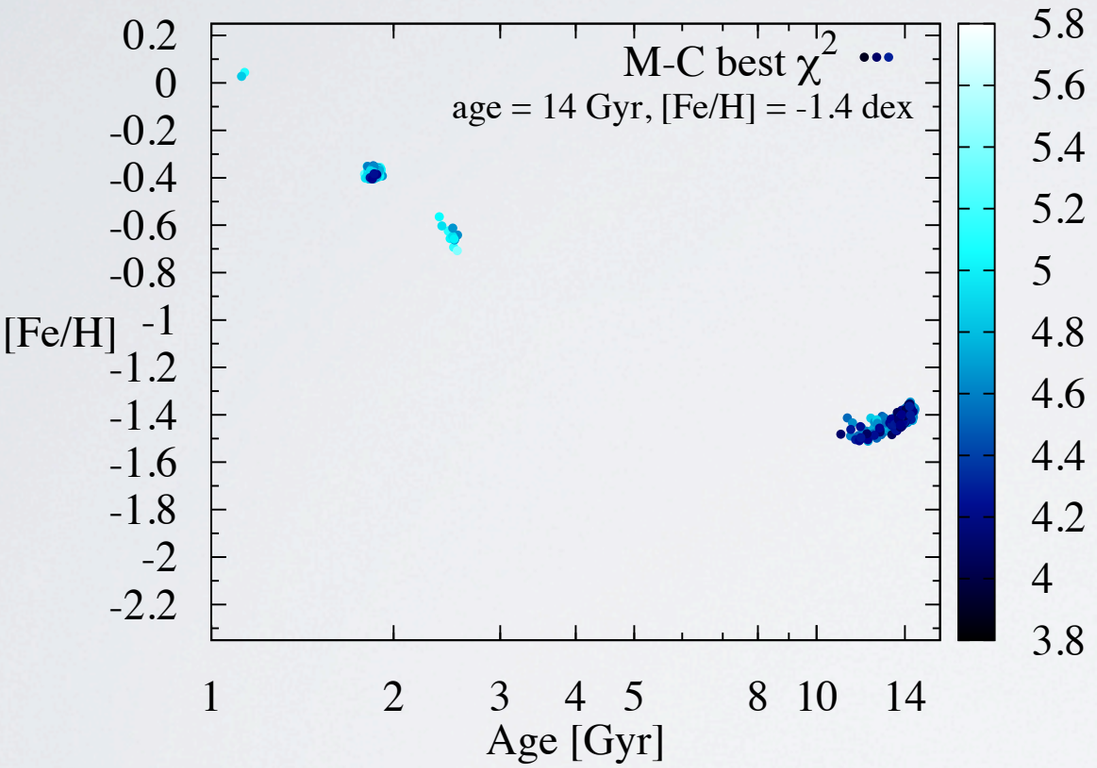
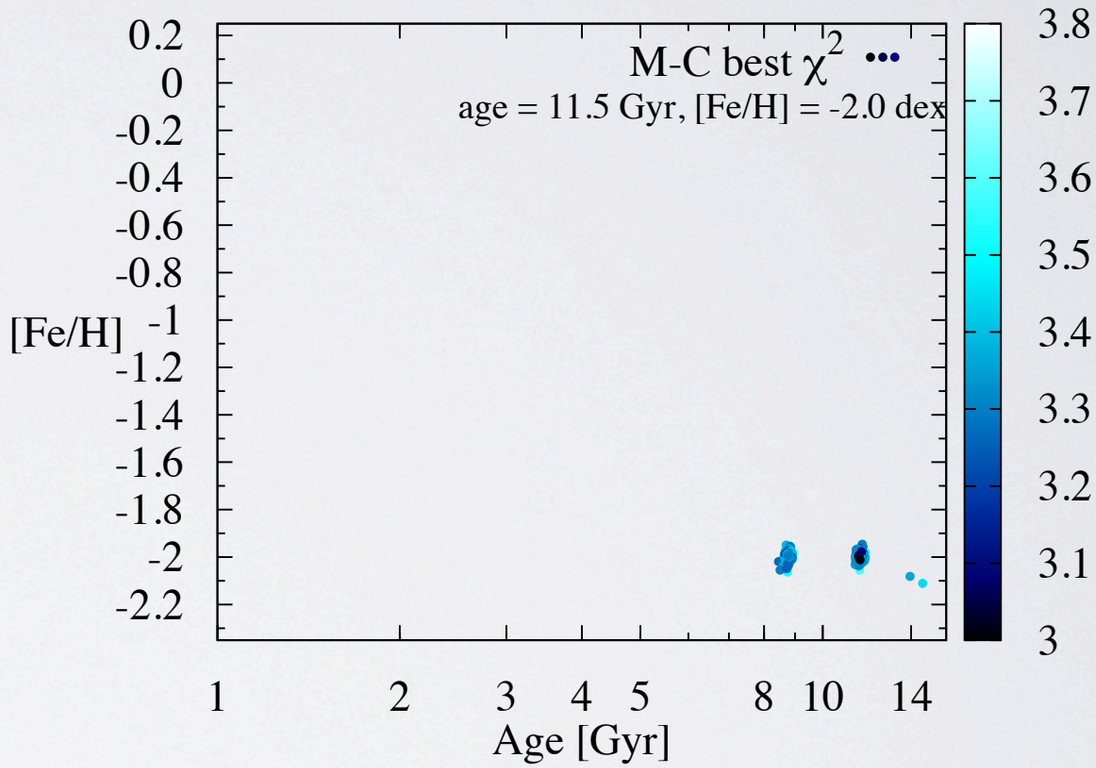
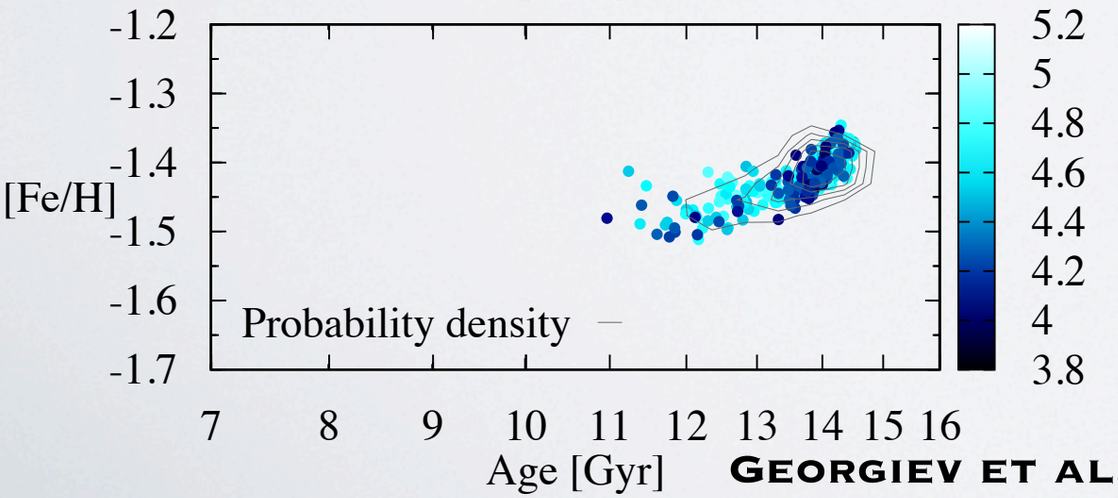
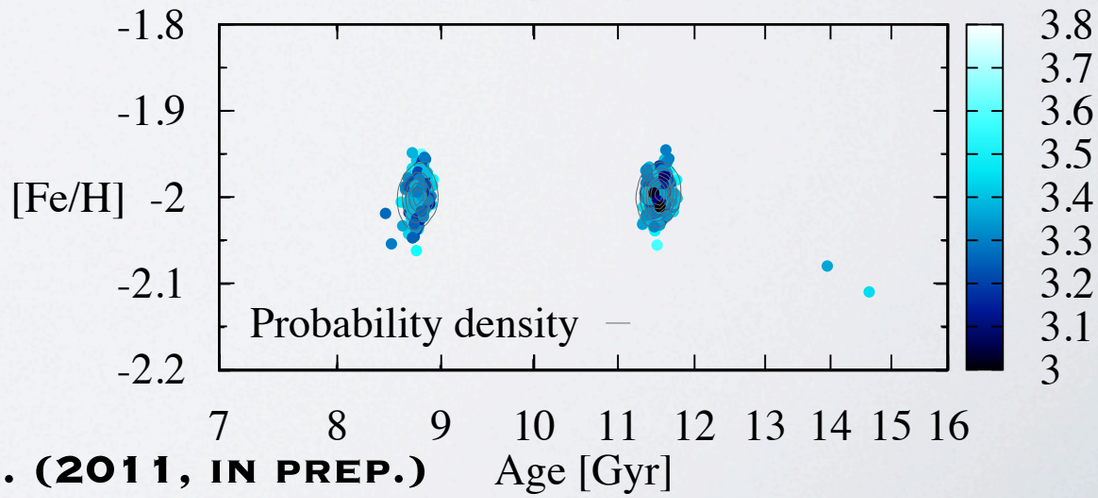












Georgiev et al. (2011, in prep.)

ESO 059-01

Age = 14 Gyr, [Fe/H] = -1.4 dex

ESO 223-09

200 Myr, [Fe/H] = -0.2 dex

IC1959

4.5 Gyr, [Fe/H] = -1.7 dex

11.5 Gyr, [Fe/H] = -2.0

KK 197

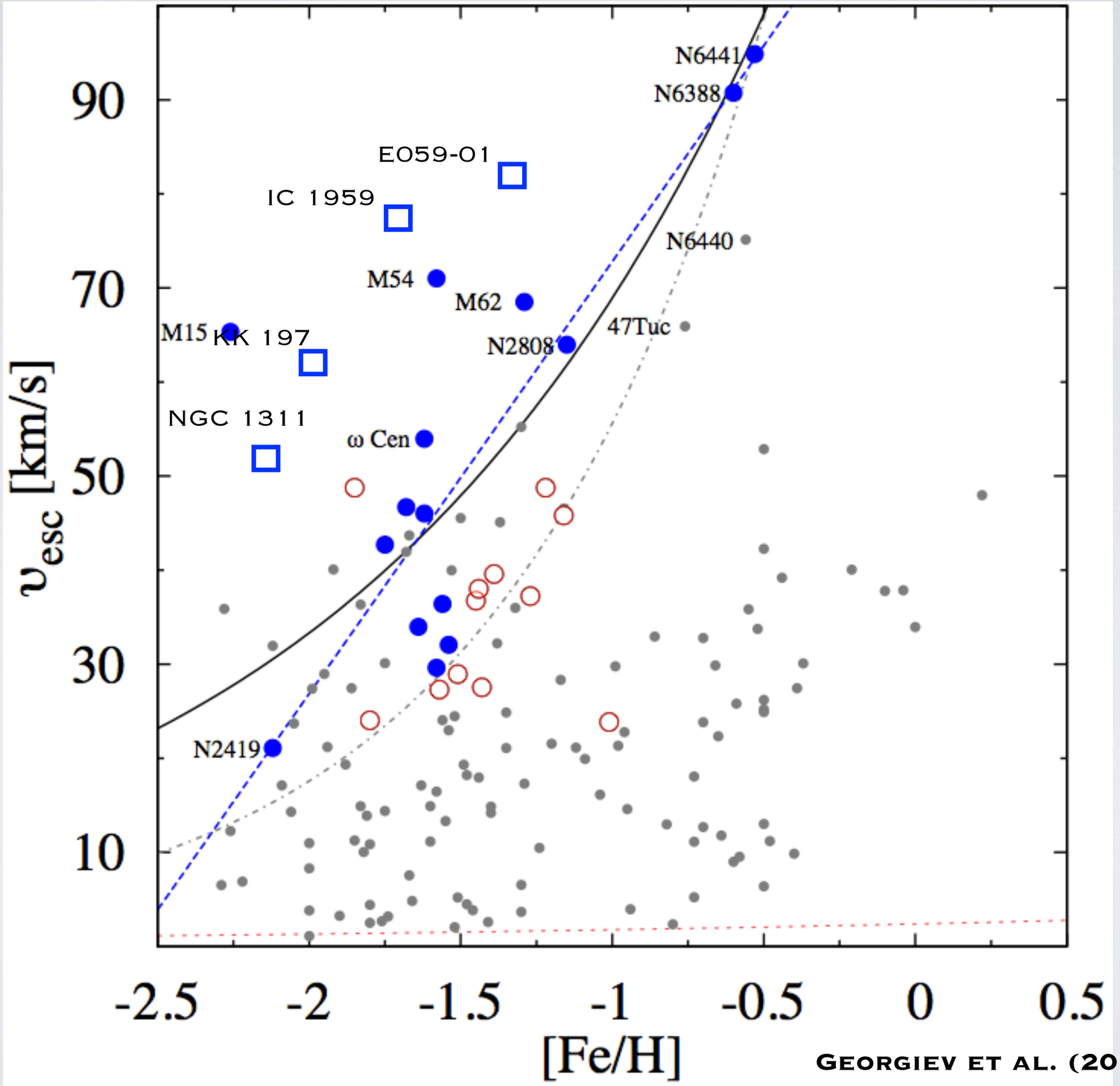
8.5 Gyr, [Fe/H] = -2.1

ESO 269-58

8.5 Gyr, [Fe/H] = -2.1

NGC 1311

V_{esc} vs. Metallicities for nGCs and EHB-GCs



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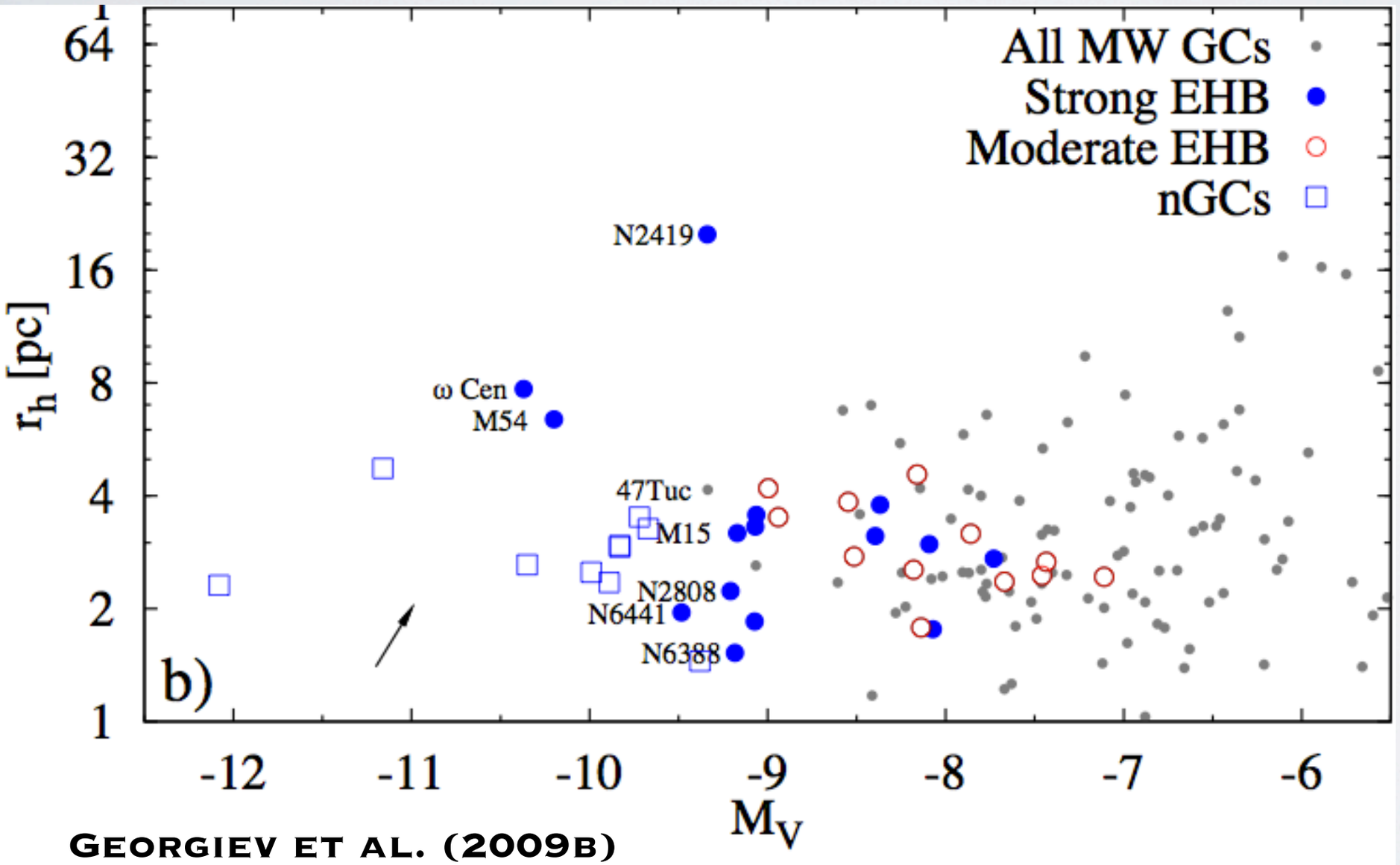
Expansion of nGCs by potential removal



Georgiev et al. (2009b)

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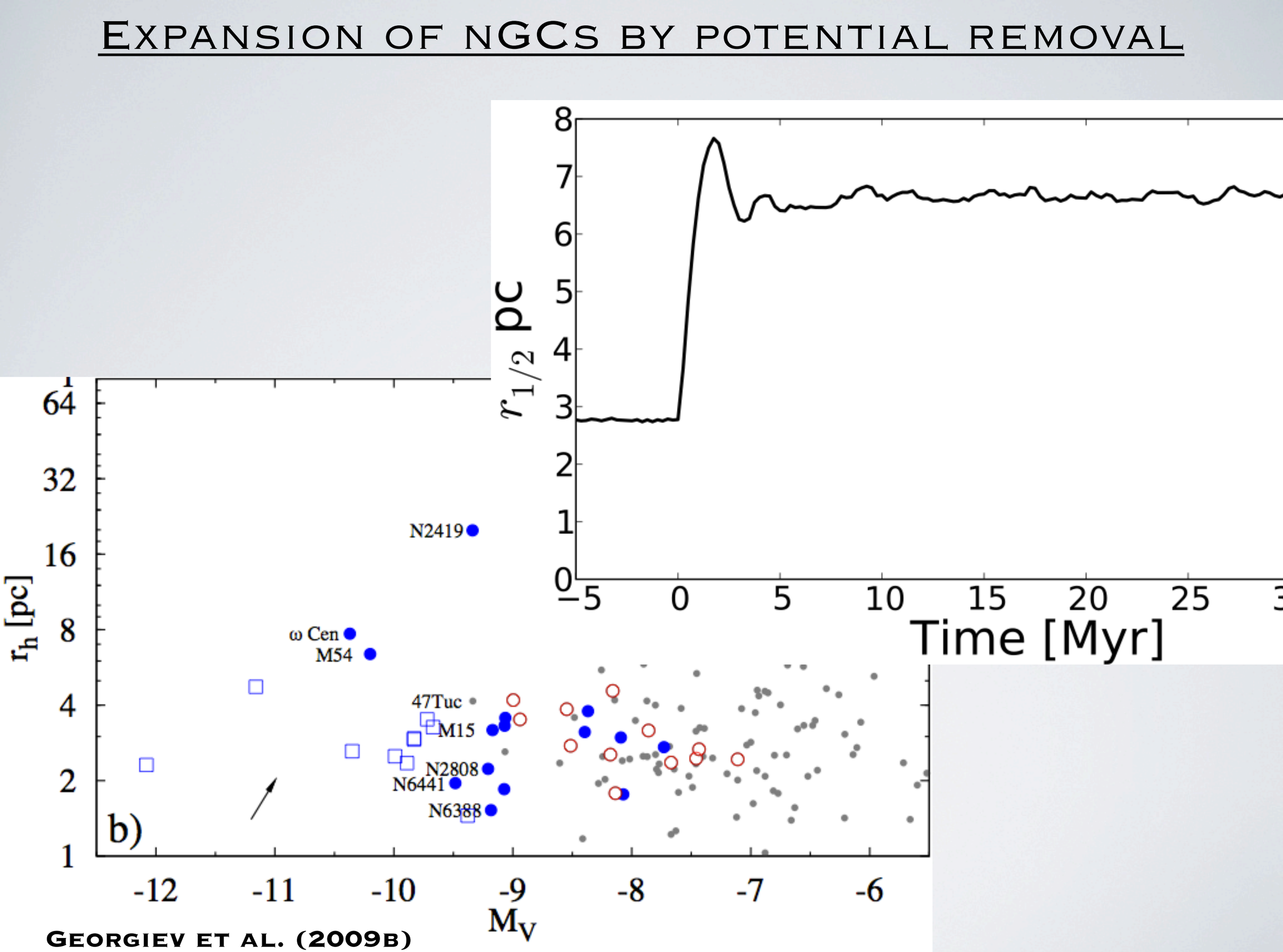

Georgiev et al. (2009b)

Conclusions

Ages and metallicities of nGCs

Cover a wide range

- in age, but mostly old (~ few Gyrs to 14Gyr)
- metallicity, but mostly metal poor ([Fe/H] < -1.5dex)
- multiple populations, Blue HBs?

Massive Galactic GCs

Require a formation in “heavy” environment

Stay Tuned

- nGCs dynamical masses (UVES)
- Dwarf galaxies kinematics